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The Department of Defense

DoD DEPARTMENTS/AGENCIES:

Department of the Navy

Department of the Air Force

Defense Nuclear Agency

BMDO Ballistic Missile Defense Organization

Special Operations Command

PROGRAM SOLICITATION 95.1
CLOSING DATE: 13 JANUARY 1995

FY 1995 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 95.1

Small Business Innovation Research Program

IMPORTANT

The DoD is updating its SBIR Mailing list. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E), found at the back of this solicitation, to DTIC. Failure to send the form will result in no future mailings of the DoD SBIR Program Solicitation to your address.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Closing Date: JANUARY 13, 1995

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Navy, Air Force, Defense Nuclear Agency, Ballistic Missile Defense Organization, and U.S. Special Operations Command hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Section 8.0 are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research or research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research or research and development has commercial potential in the private sector.

Proposers who feel that their research or research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II, a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. General Information. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
U.S. Department of Defense
OSD/SADBU - The Pentagon, Room 2A340
Washington, DC 20301-3061
(703) 697-1481

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Section 8.0 of this solicitation. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

b. Requests for Copies of DoD SBIR Solicitation. *To remain on the DoD SBIR Mailing list, send in the Mailing List form (Reference E) to DTIC.* Additional copies of this solicitation may be ordered from:

Defense Technical Information Center
Attn: DTIC/SBIR
Building 5, Cameron Station
Alexandria, Virginia 22304-6415
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6903 commercial

This solicitation is also available on floppy diskette (in Word Perfect) from DTIC for a nominal processing fee. See Section 7.1 for information about Internet access to the solicitation at DTIC.

The DoD SBIR solicitation can be obtained electronically using Business Gold, the National Technology Transfer Center's bulletin board system. Connect via Internet by telneting to **iron.nttc.edu**, or by dialing (304) 243-2560 for high speed modems (9600+) or (304) 243-2561 for 1200-2400 baud modems and logging

in as guest. For more information on the NTTC electronic bulletin board system contact:

National Technology Transfer Center
Wheeling Jesuit College
316 Washington Ave
Wheeling, WV 26003
(800) 678-6882

c. Outreach Program. The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. We have a special outreach effort to socially and economically and disadvantaged firms and to small companies that are negatively affected by the Defense down-sizing.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, <u>at the time of award</u> of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any federal agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic. Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages (excluding company commercialization report).
- Use a type size no smaller than 12 pitch or 11 point.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a Red Copy of Appendix A and Appendix B as part of the Original of each proposal.
- Do not use a proportionally spaced font on Appendix A and Appendix B.
- Include a company commercialization report listing all SBIR Phase I and Phase II projects and the commercialization status of Phase II projects (see Section 3.4.n).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding commercialization record summary, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding commercialization record summary) <u>will not</u> be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed red copy of Appendix A and Appendix B.

a. Cover Sheet. Complete <u>RED COPY</u> of Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete <u>RED COPY</u> of Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal.

The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, will not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Describe:

(1) Whether and by what means the proposed project appears to have potential use by the Federal Government.
(2) Whether and by what means the proposed project appears to have potential private sector application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of <u>two-thirds</u> of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some

items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

n. Company Commercialization Report of Prior SBIR Awards. For Phase I proposals, if the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit a Company Commercialization Report that lists the name of awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each Phase I and Phase II project, and commercialization status for each Phase II. All Phase II proposals must include a Company Commercialization Report. (This required proposal information shall not be counted toward proposal pages count limitations.)

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation. Each proposal must contain a Red Cover Sheet (Appendix A), a Red Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4.n) regardless of the number of Phase II awards received. Copies of Appendices along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing

interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government and the nation considering the following factors.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential can be evidenced by:

(1) the small business concern's record of commercializing SBIR or other research (see Company Commercialization Report, Section 3.4.n),
(2) the existence of second phase funding commitments from private sector or non-SBIR funding sources,
(3) the existence of third phase follow-on commitments for the subject of the research, or
(4) the presence of other indicators of commercial potential of the idea.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than July 15, 1995. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 500 Phase I awards from this solicitation.*

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. <u>Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.</u>

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, <u>at the discretion of the government</u>,* covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract. <u>See special instructions for each DoD Component in Section 8.</u>

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. <u>See special instructions for each DoD Component in Section 8.</u>

5.3 Reports

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A Sample SF 298 is provided in Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:

- (a) Distribution authorized to U.S. Government Agencies only; report contains proprietary data produced under SBIR contract. Other requests shall be referred to the performing organization in Block 7 of this form.
- (b) Approved for public release; SBIR report, distribution unlimited.

(3) The report abstract (Block 13 of the SF 298, "Report Documentation Page") must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract may be published by the DoD, it must not contain any proprietary or classified data.

c. Submission. <u>SIX COPIES</u> of the final report on each Phase I project shall be submitted within the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, Cameron Station, Alexandria, VA 22304-6145.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under

which monthly progress payments may be made up to 90% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)_________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit <u>classified material</u> with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a <u>period of four years</u> to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed

under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the government shall have the limited right to use such data for government purposes and shall not release such data outside the government without permission of the contractor for a period of four years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the four-year period, the government shall retain a royalty-free license for government use of any technical data delivered under an SBIR contract whether patented or not. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252-227-7013 alternate II(3) "Government Purpose License Rights".

5.9 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED RED COPY OF APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY), AND A COMPANY COMMERCIALIZATION REPORT (see Section 3.4.n).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's subsection of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, January 13, 1995. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than January 6, 1995 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the

U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding company commercialization record). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small businesses may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC, a major component of the DoD Scientific and Technical Information Program, serves DoD and other federal agencies and their contractors by providing access to and transfer of scientific and technical information resulting from and describing DoD-funded research and development.

The information assistance provided by DTIC enables organizations preparing R&D proposals to DoD to make better-informed bid decisions and technically stronger submittals. DTIC prepares a Technical Information Package (TIP) for most SBIR topics. TIPs contain a bibliographic listing of technical reports from DoD-funded work in technical areas related to the SBIR topic. TIPs may also include additional information provided by the topic author and references to other information sources.

Firms responding to this solicitation are encouraged to use Reference B at the back of this solicitation or telephone DTIC for background information covering their proposal topic areas. DTIC will return the material you request, annotated with a temporary user code for use when requesting additional information or when ordering technical reports cited in a bibliography. To support SBIR proposal preparation, reasonable quantities of technical reports from the DTIC collection are available at no cost.

Internet access to the current DoD SBIR and STTR solicitations as well as the Phase I and Phase II Award Abstracts publications is provided by DTIC. These files may be accessed via gopher at Internet address: gopher.dtic.dla.mil on port 70, or through file transfer at Internet address: asc.dtic.dla.mil (login is "anonymous", password is : your E-Mail address), under the /pub/sbir

directory.

Call, or visit (by prearrangement) DTIC at the following location which is most convenient to you. All written communications with DTIC must be made to the Alexandria, VA, address.

Defense Technical Information Center
ATTN: DTIC-User Services
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6902
(703) 274-9274 (FAX)

DTIC Boston Regional Office
Building 1103, 5 Wright Street
Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Dayton Regional Office
2690 C Street, Suite 4
Wright-Patterson AFB, OH 45433-7552
(513) 225-7905

DTIC Albuquerque Regional Office
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles Regional Office
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

For information services in the areas of manpower, personnel, training and simulation devices, human factors and safety, contact the DTIC Manpower and Training Research Information System (MATRIS):

DTIC MATRIS Office
ATTN: DTIC-AM, Sally Ames
San Diego, CA 92152-6800
(619) 553-7008

DTIC also provides access to specialized reference services and subject matter expertise within the DoD-sponsored Centers for Analysis of Scientific and Technical Information (IACs). IACs are concerned with the Scientific and Technical Information content of worldwide engineering, technical and scientific documents and databases. For more information on how to utilize the DTIC IAC program and other DoD IACs contact:

Defense Technical Information Center
DTIC-IAC Program Manager
Alexandria, VA 22304-6145
(703) 274-6260
(703) 274-0980 (FAX)

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600
(703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
237 Wisenbaker Engineering Research Center
College Station, TX 77843-3401
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical problems for which DoD Components requests proposals for innovative R&D solutions from small businesses. Topics for each participating DoD Component are listed and numbered separately. <u>Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component</u>. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B and C follow the Component Topic Sections. Appendix A is a red-printed Proposal Cover Sheet, Appendix B is a red-printed Project Summary form, and Appendix C is an outline for the Cost Proposal. An original red-printed copy of Appendix A and Appendix B must be included with each proposal submitted.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research. The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. Vincent D. Schaper
ONR 362 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-8528

All SBIR proposals should be submitted to the above address and must be received by the date and time indicated in Section 6.2 "Deadline Of Proposal" appearing in the front part of this DOD solicitation.

The Navy's SBIR program is a mission-oriented program which integrates the needs and requirements of the Navy primarily through science and technology dual-use, critical technology topics. A total of 31 Science and Technology (S&T) areas has been identified (see Table 1). While all of these areas may not be funded equally during the two annual DOD SBIR solicitations in which the Navy participates, topics will be funded according to a priority it has established to meet its mission goals and responsibilities.

This solicitation contains a mix of broad topics and single narrow topics. Please read the information contained in this solicitation carefully before sending your proposal. This solicitation contains a greater amount of broad topics, permitting greater latitude for small businesses to submit their solutions to Navy requirements. Be aware that the Navy is attempting to determine the effectiveness of such a solicitation. Your reaction to the form and substance of these solicitation topics vis-a-vis those of previous solicitations sent on a separate sheet of paper along with your proposal would be appreciated. Also be aware that the Navy is shifting the participation emphasis of its SBIR Program solicitation from the first solicitation (eg 95.1) to the second solicitation of the fiscal year (eg 95.2). Therefore this solicitation has is a lower level of participation (fewer topics) from Navy activities. This solicitation does have participation from Marine Corps, Naval Air Systems Command, and Naval Sea Systems Command.

When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of successful Phase I effort will be eligible for a Phase II award. All Phase I and Phase II proposals should be sent to the Navy SBIR Program Office for proper processing. Phase III efforts should be reported to the SBIR program office noted above.

As in the past solicitation the Navy will provide potential awardees the opportunity to reduce the gap between Phases I & II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. The Phase I Option should be the initiation of the demonstration phase of the SBIR project (i.e. initial part of Phase II). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II); 2) a transition or marketing plan (formerly called "a commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the transition plan is evaluated as being successful. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II option will be limited to 40 pages. The transition plan should be in a separate document

Evaluation of proposals to the Navy will be accomplished using in-house Navy and other government scientific personnel, depending on the topic or proposals involved. Selection of Phase I proposals will be based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY	SCIENCE
Aerospace Propulsion and Power	Computer Sciences
Aerospace Vehicles	Mathematics
Chemical and Biological Defense	Cognitive and Neural Sciences
Command, Control, and Communications	Biology and Medicine
Computers	Terrestrial Sciences
Conventional Weapons	Atmospheric and Space Science
Electron Devices	Ocean Science
Electronic Warfare	Chemistry
Environmental Quality and Civil Engineering	Physics
Human-System Interfaces	Electronics
Manpower and Personnel	Materials
Materials and Structures	Mechanics
Medical	Environmental Science
Sensors	Manufacturing Science
Surface/Undersurface Vehicles	
Software	
Training Systems	

SUBJECT/WORD INDEX TO THE NAVY SBIR 95.1 SOLICITATION

DEPARTMENT OF THE NAVY SBIR 95.1 SOLICITATION TOPIC TITLES

N95-001	Affordable Sensors and Avionics
N95-002	Reconfigurable and Adaptive Avionic and Sensor Suites
N95-003	Increased Reliability and Maintainability of Avionics and Sensors
N95-004	Eyesafe Laser Threat Warning Capability
N95-005	Surface Discharge (SD) Low Frequency Acoustic Source
N95-006	Improved Attitude/Orientation Measurement Capability
N95-007	Fiber Optic Coupled Infrared Focal Plane Array (FOCIRFPA)
N95-008	Radar Cross Section (RCS) Reduction Using High Temperature Superconductors (HTS)
N95-009	Optical Retromodulated Communication and Tracking System
N95-010	Investigate a Robust and Secure Means of Communication for Command and Control of the Multiple Robotic Vehicles and Transfer of Intelligence Data
N95-011	Biodegradable Ocean Sensors
N95-012	Exploiting Chaos for Signal Processing
N95-013	Automatic Data Fusion Display
N95-014	Advanced Signal Processing of Impulsive Waveforms
N95-015	Wavelet Techniques for Compression of Acoustics Processing Signals
N95-016	Development/Integration of Low Cost, Lightweight Collision Avoidance/Identify Friend or Foe (IFF) Capability for Hand Launched Unmanned Aerial Vehicle (UAV) System.
N95-017	Prototype Active Acoustics Technology for Use in Classifying Underwater Targets in Shallow Water.
N95-018	Cryogenic Detector Package for Multiple Arrays
N95-019	Lightweight, High Power/Energy Density, Rechargeable Battery for Robotic Technology Applications
N95-020	Solid State Pulsed Power Driver
N95-021	Virtual Reality
N95-022	Intelligent Interface for Mission Rehearsal
N95-023	Automated Feature Extrusion for Photo-real Perspective Scenes
N95-024	Quick Response Terrain Visualization
N95-025	Real Time Image Compression with Edge Feature Retention for Use During Airborne Reconnaissance
N95-026	Spatial Acoustic Sound for Virtual Environment Applications

N95-027	Referee Receiver Processing System
N95-028	Ceramic Fasteners for Aircraft Joining Applications
N95-029	Aircrew Head Support
N95-030	High Speed Three Dimensional (3-D) Scanning of Complex Air Flow Fields
N95-031	Innovative Small, Heavy Fuel Engine Concepts
N95-032	Next Generation Electrolytes for Use in Electrochemical Machining (ECM)
N95-033	Structural Fatigue Assessment via NDT/I Techniques
N95-034	Durability Modeling of Fiber Reinforced Ceramic Matrix Composites
N95-035	Acoustic Sensors Used for Gearbox Vibration Monitoring and Diagnostics
N95-036	Advanced Turbine Exhaust Particulate Measurement System
N95-037	Engine Composite Blade and Vane Repair
N95-038	Advanced Automatic Test System (ATS) Resources
N95-039	Automated Composite Scarfing/Step Machining Apparatus for Curved Structures
N95-040	Weapon Systems Improvements
N95-041	Sensitive Uncooled Micromechanical IR Detector
N95-042	Environmentally-Durable, Electrically-Conductive Coatings for High Speed Aircraft Windows and Missile Domes
N95-043	Wavelet Transforms in Electronic Warfare (EW) Signal Processing
N95-044	Increasing Frequency Coverage of High Temperature Superconducting Antennas for VHF/UHF Applications
N95-045	GPS CCM Improvements
N95-046	GPS Telemetry Transmitter
N95-047	Arrays of Conformal Waveguide
N95-048	Systems and Technologies for Future Amphibious Warfare
N95-049	Develop Naval Gunfire Defense against Anti-Ship Missiles
N95-050	Simulation of Optical Environmental Effects
N95-051	High Repetition Rate Mid-Infrared Lasers
N95-052	Combat System Interface Simulation/Stimulation
N95-053	Submarine Portable Launch System

N95-054	Submarine Low Cost Littoral Water Sonar Passive Localization System
N95-055	Development of Adaptive Filtering System to Eliminate CW Interference in Submarine IFM-Based Electronic Support Measure (ESM) Systems.
N95-056	Low Light Level Color Imaging with Image Processing
N95-057	Innovative Passive Electromagnetic Sensors for Submarines
N95-058	Develop an Active Advanced Signal Processing Techniques for Active Sonar Contact Classification
N95-059	Develop Adaptive Neural Network Signal Processing
N95-060	Develop Advanced Directed Energy/Blast Warheads for Torpedo Applications
N95-061	Develop Active/Passive Data Fusion Operator Associate
N95-062	Exploration of Sources of Opportunity for Submarine Sonar Systems
N95-063	Develop the Dynamic Behavior of a Unmanned Undersea Vehicle (UUV) Surf Zone Vehicle Control
N95-064	Radar Simulation
N95-065	Develop Concepts for Delivering Logistic Information
N95-066	Semi-Portable Antenna Near-Field Scanner
N95-067	Develop Robust Estimation for Target Tracking

DEPARTMENT OF THE NAVY
SBIR 95.1 TOPIC DESCRIPTIONS

NAVAL AVIATION REQUIREMENTS

PRODUCT AREA: Avionics and Sensors for Naval Aircraft

Navy landbased and shipbased aircraft require improved sensor and avionics systems to enable them to perform functions of surveillance, fire control, electronic warfare, battle damage assessment, information management and dissemination, and others, in support of Joint Strike, Joint Littoral, and Joint Surveillance missions. Targets and environments of interest include underwater objects (submarines, mines) particularly in shallow waters, ships, aircraft, and land targets in ocean and near-shore environments, under conditions of day and night, all weather, electronic jamming, and deception.

To meet these goals the Navy is looking for innovative solutions which promise measurable improvements in any (or all) of the following three broad areas. The Navy will provide a minimum of two awards from quality proposals from the total proposals received for these first three topics:

N95-001 TITLE: Affordable Sensors and Avionics

OBJECTIVE: To improve operational effectiveness in Naval sensors and avionics at an affordable cost.

DESCRIPTION: Affordable sensors and avionics which improve operational effectiveness in areas of detection, identification, location, and tracking. Sensor or processing concepts which apply to single sensors, multiple sensors, or multiple platforms are of interest.

PHASE I: Show feasibility of the concept.
PHASE II: Demonstrate the product.
PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: The technology developed under this SBIR should be useable in the civilian market.

N95-002 TITLE: Reconfigurable and Adaptive Avionic and Sensor Suites

OBJECTIVE: To develop reconfigurable and adaptive avionic and sensor suites.

DESCRIPTION: Reconfigurable and adaptive avionic and sensor suites which allow aircraft to be more responsive to unanticipated changes, whether they are caused externally (i.e. the threat environment), or internally (i.e. system failure). Architectural and engineering concepts, which apply evolutionary acquisition approaches to aircraft hardware and software, to ease integration of new systems, and enable reconfiguration of existing systems, are of interest.

PHASE I: Show feasibility of the concept.
PHASE II: Demonstrate the product.
PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: The technology developed under this SBIR should be useable in the civilian market.

N95-003 TITLE: Increased Reliability and Maintainability of Avionics and Sensors

OBJECTIVE: To increase reliability and maintainability of avionics and sensors.

DESCRIPTION: Increased reliability and maintainability of avionics and sensors to maximize availability and minimize mission degradation caused by system failures. Concepts employing fault tolerant hardware and software, and use of common modules (i.e. processors, apertures) are of interest.

PHASE I: Show feasibility of the concept.
PHASE II: Demonstrate the product.
PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: The technology developed under this SBIR should be useable in the civilian market.

N95-004 TITLE: Eyesafe Laser Threat Warning Capability

OBJECTIVE: Provide adequate threat warning for future countermeasures systems to be deployed on Naval tactical aircraft.

DESCRIPTION: There is a trend toward constructing laser-guided weapons and laser rangefinders that pose no ocular hazards to friendly forces. The optimum wavelength lasers for eye safety that are the safest operate at 1.54 microns, where the energy is not focused on the retina or absorbed on the cornea but is absorbed in the vitreous humor. The technology to produce lasers capable of operating in the 1.2 - 2.1 micron region of the spectrum is currently available and eyesafe laser systems are presently on the market. These systems are based on Raman-shifted Nd:YAG sources, Erbium-based sources, and will eventually include tunable Optical Parametric Oscillator (OPO)-based sources. This effort will produce a laser warning sensor that will provide adequate warning to EOCM (Electro-optic Countermeasure) systems.

PHASE I: Provide a feasibility study which develops a method to detect eyesafe laser threats at ranges beyond 10 kilometers. This method should cover the near infrared spectrum from 1.1 to 2.1 microns, and must be sensitive at 1.54 microns. The method must include a flexible fiber bundle (> 6 meters length) between the collection optics and the detector to provide isolation against radio frequency interference. The method must identify the laser wavelength to within 20 nanometers, and must classify the laser pulse repetition rate and angle of arrival to within 10% and 3 degrees, respectively.

PHASE II: Develop, test and operationally demonstrate the eyesafe laser warning sensor outlined in PHASE I.

PHASE III: Produce the system demonstrated in the PHASE II effort.

COMMERCIAL POTENTIAL: The detector and fiber technology utilized under this effort will benefit high-bandwidth communications research.

N95-005 TITLE: Surface Discharge (SD) Low Frequency Acoustic Source

OBJECTIVE: To Develop Surface Discharge Technology Required for a Controllable Impulsive Acoustic Source.

DESCRIPTION: The Navy is currently using air deployed underwater Sound Underwater Source (SUS) charges to gather oceanographic data. These explosive sources are single charges which yield a nondirectional high power broadband pulse. The disadvantages of these explosive sources are that only one explosive can be packaged per air deployed container and that safety requirements for handling, shipping and storing explosives add costs and constraints to fleet operations. The surface discharge (SD) is a pulsed electrically driven acoustic source generically similar to sparkers. The technology will provide a broadband low frequency acoustic output with multiple ping capability. In addition safety and environmental concerns involving explosives would be eliminated.

PHASE I: The program of research will lead to a demonstration of a three element array at sea. PHASE I will consist of evaluating the technology for A size sonobuoy application. A design study shall be conducted to determine:

(1) The acoustic and electrical efficiency requirements for the source to provide a minimum of four pings at ESL (Energy Source Level) comparable to a four pound SUS charge and packaged in an A size sonobuoy.

(2) The timing accuracy capability for a potential multipulse application.

PHASE II: Develop a single element with driver and test at Lake Seneca. Develop three element over-the-side deployed array for at sea demonstration testing. The array shall include acoustic elements, driver, and power source (battery).

PHASE III: Incorporate the technology into existing programs.

COMMERCIAL POTENTIAL: Technology may have application to oil/seismic exploration. Presently explosive charges are used which require costly safety ,handling and storage methods which would be eliminated with the surface discharge device. In addition multiple blasts from a single device could be provided which would increase the data rate as well as eliminate the need to replenish the fields.

N95-006 TITLE: Improved Attitude/Orientation Measurement Capability

OBJECTIVE: Substantially enhance the cost vs. performance aspects of means to determine the attitude or angular orientation of a wide variety of moving devices and platforms, considering both long-term (i.e. absolute orientation) and short-term (i.e.

drift and noise) effects.

DESCRIPTION: Gyroscope assemblies of various designs are commonly used to determine the angular orientation of a wide variety of moving devices and platforms, ranging, for example, from vehicle-mounted radar and electro-optical (EO) sensors, up to the vehicle itself. The use of such gyro assemblies entails significant cost/performance trades, with the compactness and high performance needed for demanding applications commanding a high price. Exploiting the principle of using the gyro assembly in an inertial measurement unit (IMU) configuration, and thereby referencing it to the highly accurate velocity data provided by GPS, can provide substantial system cost reductions by enabling the use of a lower performance (and cost) gyro assembly than would otherwise be required for a given level of system performance.

PHASE I: Conduct a performance analysis and design study which predicts the improvements in attitude measurement performance as well as the reductions in system cost achievable through the use of techniques for referencing gyro assemblies to Global Positioning System (GPS)-derived velocity data. Assume the use of gyro assemblies occupying a range of cost/performance "plateaus"; for example, attempt to show that these techniques can make low-cost gyros useful in mid-range applications such as integrated aircraft navigation/flight control at one extreme, while allowing compact ring laser gyros (RLGs) to provide the extremely high performance needed for advanced EO sensor sightline measurement at the other.

PHASE II: Integrate, test, optimize, and demonstrate at least two attitude-determining assemblies based on the referencing of gyros to GPS velocity data, to exhibit the performance enhancement available through use of such a combination. One assembly should be based on use of low-cost gyros and the commercially-available Sensor Positioning System (SPS), to show applicability in mid-range applications. The other should use a compact high performance triad, and the encrypted GPS capability precise position system (PPS) available to government users, to achieve the extremely high attitude measurement accuracy required for advanced EO sensor sightline measurement.

PHASE III: Engineer a product line of complete embeddable "orientation engines" (similar to the vision of a compact GPS receiver as an embeddable "position engine"), which marry a GPS receiver with an IMU assembly and the appropriate embedded processing; this product line will span the range of cost/performance from low-cost commercial applications at one end to high performance military units at the other.

N95-007 TITLE: Fiber Optic Coupled Infrared Focal Plane Array (FOCIRFPA)

OBJECTIVE: To develop coherent fiber optic bundles for remote location of infrared focal plane arrays (IRFPA) operating in the 2.0 to 4.8 microns (m) spectral band.

DESCRIPTION: For the application of aircraft missile warning, the Navy is seeking innovative approaches in the development of coherent fiber optics (FO) bundles. Currently, the Navy is developing passive missile warning receiver (MWR) systems for tactical aircraft using IRFPA's (i.e. Rockwell Hybrid Mercury Cadmium Teriluride (MCT) 25x256 element array) to sense the plume radiation of approaching missiles. Location of the MWR system within the aircraft structure provides the following advantages (a) no aerodynamics obstruction or effects; (b) low radar/optical cross section; (c) low Electromagnetic Interferometer (EMI); (d) convenience in location; and (e) integrated system design with wide angular coverage. The FO bundle shall transfer an input image of 10 millimeter diameter formed by an f/1.3 objective lens over a distance of 10 meters with a maximum loss in transmission of 50% over the spectral band of 2.0 to 4.8 m. The optical quality in terms of resolution and modulation transfer function shall be optimized to provide minimum degradation to an IRFA such as the Rockwell Hybrid MCT 256 x 256 element array with 40 um pixel center to center spacing.

PHASE I: Provide a feasibility study which develops a demonstration of concept utilizing mid-infrared fibers and a portion of the elements of an IRFPA. Perform an analytical study to address fabrication issues to be resolved in development of a coherent fiber bundle during PHASE II FO bundle performance assessment.

PHASE II: A prototype coherent fiber optic bundle based upon PHASE I study will be fabricated, tested and evaluated. The performance will be demonstrated by using a government provided IRFPA and objective lens.

PHASE III: Produce advanced model of fiber-optic coupled infrared Focal Plane Array developed in PHASE II.

COMMERCIAL POTENTIAL: FOCIRFPA commercial applications include diagnostics, like thermography inside engines and machinery; and remote spectroscopy for industrial process control and organic reaction monitoring.

N95-008 TITLE: Radar Cross Section (RCS) Reduction Using High Temperature Superconductors (HTS)

OBJECTIVE: Develop radar cross section (RCS) reduced antennas using high temperature superconducting (HTS) and electrically small designs. Obtain data on the change in RCS due to the transition from the normal state to the superconducting state in HTS compared to a normal metal antenna.

DESCRIPTION: Conduct RCS measurements on both existing Government and new and innovative contractor antenna designs. (The Government antenna design for a 500MHz thin film antenna described in IEEE 39(9), 1498). The Government described antenna design is an electrically small half loop and matching network which fits onto a 0.8" x 0.8" substrate. Any and all RCS reduction techniques (including electrically small designs and HTS in the normal state) may be considered for the new and innovative designs.

PHASE I: Develop sufficient data to demonstrate feasibility of an innovative reduced design using HTS as a substitute for normal metal. Provide a report describing the demonstration antenna or antenna system design.

PHASE II: Fabrication and demonstration/comparison of the proposed antenna with other conventional systems of the same functionality. (The Government facilities at China Lake, CA may be made available for the test subject to prior coordination.)

PHASE III: Integrate the proposed reduced RCS antenna into a selected aerial target system for demonstration and evaluation.

COMMERCIAL POTENTIAL: Commercial application possibilities for electrically small antenna technology would include any application where space and/or weight is limited and where power gain and bandwidth requirements are low and where the frequencies are below 2 Ghz. Additionally, the techniques used to modulate RCS should be used to create microwave switches which could prove useful in designing more generic microwave switching devices for commercial purposes.

N95-009 TITLE: Optical Retromodulated Communication and Tracking System

OBJECTIVE: To provide a secure line of sight (LOS) optical communications (both voice and data) and tracking link between US Naval aircraft and aviation capable ships.

DESCRIPTION: During the approach and recovery of aircraft (fixed wing, rotary wing and VSTOL) on aviation capable ships, it is essential that the ship and aircraft be able to exchange information over a secure and dedicated transmission link. Exchange of vital recovery data, as well as voice information and commands, is required to assure safe recoveries. Aircraft operations in degraded weather and the potential of a future move towards closed/darkened cockpits adds to the need for this link. An optical solution utilizing 2-5 micrometer laser technology is envisioned.

The optical communications/tracking concept envisioned, but not limited to, could be divided into two main subsystems, a shipboard laser transmitter/receiver and an aircraft retromodulator/receiver. The system should operate over a range of 3 nautical miles to as close as 50 feet while maintaining LOS track of the aircraft. Conceptual systems should utilize an eye-safe, mid-infrared (MIR) wavelength (2-5 micrometer) laser. A MIR wavelength system is desired because it will provide good transmission, higher eye-safety limits than smaller wavelengths, potential use of uncooled detectors, and less costly optical components than for longer wavelengths. Additionally, successful integration of an optical system onto an aircraft platform requires a device mounted on an aircraft's front nose landing gear which is small, lightweight, and is capable of withstanding the dynamic forces involved in landing an aircraft on the deck of a ship.

PHASE I: Provide a feasibility study which develops both a means of optically communicating between aircraft and ship, and a means of tracking the aircraft utilizing MIR. This study should include a definition of system requirements (i.e. format, data rates, types of data, etc), analysis of potential concepts and a determination of the most viable. This study should also consider variants of the main topic such as one-way vs two way communication, communication vs tracking, etc.

PHASE II: Develop, test and operationally demonstrate a flight worthy system with the culmination being the integration into a civil aircraft and a landbased flight demonstration.

PHASE III: Installation and test of a fully operational prototype system on a Navy aircraft operating at sea. To provide a secure line of sight (LOS) optical communications (both voice and data) and tracking link between US Naval aircraft and aviation capable ships.

COMMERCIAL POTENTIAL: New concept can be used in communications, security and surveillance systems, could be used on commercial seabased oil platforms for aircraft approach and landing and also for civil aviation transportation.

N95-010 TITLE: Investigate a Robust and Secure Means of Communication for Command and Control of the Multiple Robotic Vehicles and Transfer of Intelligence Data

OBJECTIVE: Develop a low cost, lightweight, and jam resistant multi-channel/multi-access communication system to support robotic reconnaissance and other intelligence gathering applications. The system must provide precise location and command and control of multiple autonomous surveillance platforms simultaneously, overcome the intense electromagnetic interference problems of the battlefield environment, and provide a secure means of transferring high resolution imagery data for exploitation by the user in near-real-time, etc.

DESCRIPTION: Many applications in DoD intelligence operations, including minefield location and surveying and tactical surveillance and intelligence collection, will benefit from the emerging development of small robotic technologies for use on airborne and ground reconnaissance platforms. Robotic reconnaissance systems can enable the successful execution of missions which are currently impossible to perform, can remove people from hazardous environments, and can significantly reduce the cost of operations.

The operator of the robotic vehicles must know the precise position of these vehicles, be able to control their operations, and receive the intelligence data from their sensors in near-real-time. Effective and robust communication between the surveillance platforms and the central controlling station must be provided to accomplish these tasks. This communication is currently being accomplished using commercial data links. The current data links provide only point to point communication, have insufficient data rates, lack security, and are very vulnerable to interference or deliberate jamming. The mission flexibility and operational efficiency of having multiple robotic vehicles reconnoitering a wide area is not possible. Moreover, current state-of-the-art military communications equipment is too large, expensive, and bulky for use on the small robotic platforms.

The robotic communications requirements must focus on a robust waveform that will be less susceptible to RF interference, have sufficient bandwidth for video imagery transfer with enhanced security features, provide multi-access/multi-channel communications between many robotic vehicles and their ground control station, and allow large scale and extended range operation. The proposed robotic communications technology thrust shall concentrate on the following areas of interest: advanced communication signal generation, coding and processing schemes, high density, miniaturization of electronic circuitry with very low power dissipation and be affordable.

PHASE I: Investigate secure and jam resistance multi-channel/multi-access communication technology and the requirements to evaluate MMIC, high density digital components, low voltage technology, link analysis, and tradeoffs.

PHASE II: Develop prototype hardware and demonstrate a secure, jam resistant, multi-channel/multi-access communication system which must be low cost and lightweight to be suitable for use on robotic vehicles.

PHASE III: Produce the advanced communications system for integration on robotic vehicles and operational testing.

COMMERCIAL POTENTIAL: The low cost and lightweight multi-channel/multi-access communications system for robotic vehicles will have many commercial applications such as wireless high speed Local Area Network, remote and secure video distribution, and teleconferencing via mobile phones, etc.

N95-011 TITLE: Biodegradable Ocean Sensors

OBJECTIVE: Develop biodegradable hardware components for existing and future sensor systems used in the world's oceans.

DESCRIPTION: Military, civilian, and academic organizations have for many years deployed great quantities of sensors into the oceans of the world for a variety of purposes including submarine detection, oil exploration, and scientific research. A substantial amount of the equipment is considered expendable and while its actual useful life may be short, it is never recovered. At best, it litters the ocean floor without harm to the ecosystem and at worst, degrades in a manner that contributes pollutants and floating debris to the sea. With the current awareness of our responsibility to the environment, there is a need to develop expendable (low Cost) systems which can safely be deployed in the ocean, perform their respective missions, and degrade harmlessly. Typical components include batteries of varying chemistry, floatation devices, electromechanical and fiber optic cables, and watertight housings.

PHASE I: Conduct a survey to identify the kinds of expendable equipment being produced for use in the ocean. As a specific example, analyze a production sonobuoy in detail, and identify innovative concepts for enhancing degradability and reducing negative environmental impact. Assess the impact on producibility and cost.

PHASE II: Follow up on the sonobuoy example by selecting components which have the highest potential for payoff environmentally and represent a significant innovation. Fabricate prototype models and conduct tests to assess/demonstrate degradability relative to corresponding state-of-the-art components.

PHASE III: Modify a representative number of fully functional production sonobuoys and conduct an at sea demonstration of operational performance along side non-modified units. Select a device having a primarily civilian application and repeat the PHASE II component fabrication and degradation test.

COMMERCIAL POTENTIAL: Innovations in environmental degradation in the ocean can be applied to civilian activities such as oil exploration and scientific research.

N95-012 TITLE: Exploiting Chaos for Signal Processing

OBJECTIVE: Use the principles or tools of chaos to develop signal processing methods which are significantly enhanced over conventional methods.

DESCRIPTION: Over the last two decades there has been a marked increase in the understanding and development of analysis tools pertaining to nonlinear phenomena. In particular, the field of nonlinear dynamics has provided new insights into the characterization of nonlinear time varying signals. In this effort we seek to apply this new technology and its implications to the field of signal processing. Any methods which will provide real gains over conventional signal processing for detection and classification of signals submersed in noise are of interest in this SBIR.

PHASE I: In the first the contractor will delineate new methods of signal processing using or incorporating techniques from nonlinear dynamics. New methods must be supported by pertinent theoretical considerations and computer simulations. If, for example, the detection problem is being addressed then the appropriate receiver operating characteristic (ROC) curves must be supplied. Any gains purported must be substantiated with quantitative results.

PHASE II: In PHASE II the techniques developed in PHASE I will be applied to real data and quantitative evaluations made. Several cases of real data must be considered and evaluated so as to reduce the statistical uncertainty associated with any data analysis and processing methods.

PHASE III: Prototype signal processing systems will be developed and tested.

COMMERCIAL POTENTIAL: The application of this technology to commercial problems is considered highly probable since the occurrence of chaotic signals is likely. In fact, chaotic signals are potentially present in any nonlinear system. Applications could include medical diagnostics, economic analysis, equipment design, forecasting and prediction, etc.

N95-013 TITLE: Automatic Data Fusion Display

OBJECTIVE: Fuse data from advanced multibeam/multimode sensors as well as existing sensors on a high level overview display format.

DESCRIPTION: Advanced multibeam sensors currently under development will significantly increase the amount of data which must be presented to a system operator. In addition, advanced multistatic systems will present the operator with confusing combinations of contact associations if presented on traditional displays. Planned improvements in aircraft display processing capabilities as well as a proposed color display capability can be utilized to reduce and simplify the information presentation to an operator.

PHASE I: Design an innovative data fusion technique or algorithm which simplifies the acoustic data operator-machine interface on Naavy ASW aircraft. The candidate technique may utilize existing, planned, or proposed aircraft display subsystems. In addition, the candidate technique must be capable of accommodating all existing sensors and planned sensors; acoustic or non-acoustic.

PHASE II: Develop, test and operationally demonstrate a working prototype of the best data fusion techniques investigated under the PHASE I SBIR effort on Navy ASW platform.

PHASE III: Produce the fusion techniques demonstrated in PHASE II.

COMMERCIAL POTENTIAL: The data fusion techniques investigated can be applied to future advanced multisensor automobiles and multisensor medical diagnostic equipment.

N95-014 TITLE: Advanced Signal Processing of Impulsive Waveforms

OBJECTIVE: Develop an impulsive acoustic source configuration in conjunction with an advanced signal processing technique or algorithm for the purposes of extracting additional information from received echoes.

DESCRIPTION: Multiple discreet sources can be used to achieve a pulse "signature" of the transmit waveform as well as focusing the transmitted energy in the desired direction. The signature pulse is designed such that it can be processed with advanced signal processing techniques to separate clutter from targets in dense environments. To achieve this goal, improvements in NAVY aircraft signal processing capability as well as breakthroughs in impulsive source technology may be necessary.

PHASE I: Design an innovative impulsive source configuration which achieves both high directivity and a signature pulse transmit waveform with desirable clutter rejection properties. In addition, design an innovative signal processing algorithm which fully exploits the properties of the transmit pulse.

PHASE II: Develop, test and operationally demonstrate a working prototype of the techniques investigated under the Phase I SBIR effort. Use of Government furnished input data will be furnished if available.

PHASE III: Produce the signal processing techniques demonstrated in PHASE II on a Navy ASW platform.

COMMERCIAL POTENTIAL: The advanced signal processing techniques and impulsive source configurations developed under this task can be applied to oil exploration beneath the sea floor.

N95-015 TITLE: Wavelet Techniques for Compression of Acoustics Processing Signals

OBJECTIVE: Determine the feasibility of utilizing wavelet transform (e.g. Morlet and Daubechies) techniques for the compression of typically large bandwidth data occurring in acoustic signal processing systems. If deemed promising, develop an algorithm based on the chosen wavelet transform(s) that accomplishes acoustic data compression.

DESCRIPTION: Two classes of acoustic signals are candidates for compression, namely, transients and those signals typically processed in the Low Frequency Analysis and Ranging (LOFAR) mode (steady state sinusoidal). Both of these data types require high bandwidth transmission from sensor units to receiver units onboard prosecuting aircraft. To demonstrate feasibility of the wavelet technology, theoretical analysis and preliminary testing must indicate a bandwidth savings of at least 25%. Also the wavelet compression must not degrade detection and/or classification performance associated with the signals. Once feasibility has been demonstrated algorithms will be developed to implement the wavelet compression techniques in a real-time scenario. The final deliverable will be algorithms to produce compression of the transient and LOFAR signals in real-time with no degradation and a test report indicating performance in terms of accuracy and speed.

PHASE I: A feasibility report which will describe the benefits/shortcomings of the technique and will indicate the approach for possible implementation.

PHASE II: Development of the algorithms for compression of the transient and LOFAR signals together with a test report indicating the results of their implementation.

PHASE III: Transition to Advanced Development

COMMERCIAL POTENTIAL: This technology could be useful in any commercial sensor/receiver unit application where high bandwidth signals are utilized.

N95-016 TITLE: Development/Integration of Low Cost, Lightweight Collision Avoidance/Identify Friend or Foe (IFF) Capability for Hand Launched Unmanned Aerial Vehicle (UAV) System.

OBJECTIVE: To investigate feasibility of developing lightweight, low cost collision avoidance (CA) and/or IFF technology or using commercially available CA/IFF systems for integration into Hand Launched UAV, then develop prototype for developmental bench and flight testing.

DESCRIPTION: There exists a need to develop and integrate CA/IFF capability into current and future Hand Launched UAV (HL-UAV) systems to improve interoperability with other low flying manned aircraft. The HL-UAV is a hand launched unmanned aerial vehicle system capable of performing tactical surveillance and reconnaissance within a 5-7 km combat radius. The HL-UAV's nominal operating altitude is between 200-500 feet above ground level. The current prototype system uses a

single ground control unit with a styrofoam/kevlar composite air vehicle. The electrically powered air vehicle has a 9 ft wingspan, is 6 ft in length, and weighs approx. 8 pounds with payload and batteries. The air vehicle carries the imaging payload (currently a black & white/color camera), electric motor (300 watt samarium-cobalt), uplink receiver, downlink transmitter, avionics and batteries. The ground control unit consists of a pilot controller, observer's monitor, uplink transmitter and downlink receiver.

The existing HL-UAV configuration relies on visual flight rules (VFR) and dead reckoning techniques for navigation and collision avoidance. Since the current HL-UAV does not employ an autopilot/navigation system - it relies solely on manual piloting and navigation. However, an autonavigation system employing global positioning system (GPS) is in development. Employment and operation of this capability, especially in airspace with low-flying aircraft (e.g., urban area with extensive helicopter traffic), could necessitate the need for a collision avoidance or IFF-type transponder. Since the HL-UAV would operate autonomously, and would have an extremely small visual and radar signature, the primary emphasis of a CA/IFF system would be to alert manned aircraft of the HL-UAV's location. The CA/IFF system could also alert the HL-UAV ground operator of manned aircraft within the airspace, allowing the ground operator to initiate automatic/manual collision avoidance procedures.

PHASE I: Determine the availability of existing CA/IFF technology and commercially available systems/components that could meet the stated requirements.

PHASE II: Provide prototype CA/IFF system for bench-level testing at a government facility. If successful, flight tests would follow. The contractor will provide on-site support throughout the duration of the testing, if necessary.

PHASE III: Transition into military and commercial systems.

COMMERCIAL POTENTIAL: Commercial "spin off" potential exists. The HL-UAV is already a front-runner for transition to other government agencies, paramilitary operations, and commercial applications. A CA/IFF transponder would help facilitate transition of the HL-UAV into commercial and civil operations, making the system more flexible, safe and capable.

N95-017 TITLE: Prototype Active Acoustics Technology for Use in Classifying Underwater Targets in Shallow Water

OBJECTIVE: The emergence of acoustically quiet threats in dense maritime activity, shallow water and littoral environments has led to the need for active acoustic search and detection systems to replace traditional passive systems. The objective is to study the feasibility and application of innovative active acoustic classification technology to the U.S. Navy maritime patrol aircraft (MPA) and sensors. The initial goal will be to establish a classification capability to reliably distinguish between blue and red (friendly/unfriendly) platforms.

DESCRIPTION: This SBIR Topic will investigate, implement, test and demonstrate prototype active acoustics technology for use in classifying underwater targets in shallow water. Areas to be investigated include: generalizing the target model to incorporate more realistic physics; using Navy-specified existing active signals at search frequencies to more effectively exploit target characteristics; using innovative signal processing techniques, in conjunction with the preceding, to extract currently unused classification information. Analyses will address such issues as: elastic reradiation, frequency filtering, and time delays induced by the target; discrimination between target and noise sources (including bottom clutter). Determine feasibility and recommend an approach having the greatest potential for shallow water active classification. Implement, test and demonstrate a prototype.

PHASE I: Develop an expanded theory of target model physics. Investigate and identify candidate signal designs and processing. Determine the feasibility of alternative approaches, taking performance and Air ASW sensor constraints into account. Document the generalized model physics, all analyses and results, and the alternative approaches in a Technical Report.

PHASE II: Generate a detailed design for a Navy approved approach to subsurface friendly/unfriendly classification in shallow water scenarios. Implement a prototype system. Test it, using quantitative measures of effectiveness, and analyze the test data to determine performance relative to current active classification capabilities. Demonstrate the prototype. Deliverables will be a Final Technical Report, the prototype system (software and hardware), and associated documentation.

PHASE III: Transition to the Air ASW communities.

COMMERCIAL POTENTIAL: Identification of underwater objects.

N95-018 TITLE: Cryogenic Detector Package for Multiple Arrays

OBJECTIVE: Develop an assembly for multiple infrared spectral band detector arrays in a single package.

DESCRIPTION: Current infrared sensor designs restrict detector arrays to a single band. Multiple band designs must rely on complex optical configurations to direct the scene energy to separate detectors. Multiple band data is important in analyzing the information for the presence of false targets originating from natural scene emissions or countermeasures. Objects with the wrong energy ratio between the bands can be classified as invalid. Real targets (ships, tanks, aircraft) will exhibit a distinct ratio reducing false alarms and providing a counter countermeasure ability. This effort will focus on the development of a detector package with the capability to provide multiple spectral data. Techniques investigated will include switchable cold filters and optically isolated multiple arrays with integral fixed filters. The resulting package will provide capability for imaging the scene and for a spectral analysis of the potential military targets present in the scene.

PHASE I: Complete the analysis of the candidate designs for a switchable filter configuration. Frame rates, package size, physical detector capacity, reliability, and mechanical complexity will be key measures of performance for the switchable detector design. Analysis of the packaging requirements for multiple fixed arrays will also be conducted noting the trade off between mechanical simplicity and physical detector areas.

PHASE II: Fabricate the superior design approach from the PHASE I effort. Interface to commercially available detector array and conduct lab tests to characterize the package.

PHASE III: Couple the package to a commercial optical telescope. Conduct lab and field tests to demonstrate real world performance.

COMMERCIAL POTENTIAL: This development could be applied to medical instrumentation imagers.

N95-019 TITLE: Lightweight, High Power/Energy Density Rechargeable Battery for Robotics Technology Applications

OBJECTIVE: To develop a lightweight, high power/energy rechargeable battery for use by small air platforms

DESCRIPTION: Many applications in DoD intelligence operations, including minefield location and surveying and tactical surveillance and intelligence collection, will benefit from the emerging development of small robotic systems for use on air and ground reconnaissance platforms. The robotic reconnaissance system can enable the successful execution of missions which are currently impossible to perform, can remove people from hazardous environments, and can significantly reduce the cost of operations.

There is a need to develop advanced rechargeable battery technology to improve the performance of existing robotic vehicles which use batteries extensively. Currently, nickel-cadmium (NiCd) battery packs, weighing about one pound and providing approximately 20 minutes of operation, are used. Lithium-sulfur dioxide ($LiSO^2$) battery packs weighing about one pound are also used and supply energy for a longer duration. These are not rechargeable and must be disposed of as hazardous waste.

The proposed battery research will focus on technology that can supply the high energy/power density performance of $LiSO^2$ batteries and still be rechargeable like NiCd batteries. The continued development and refinement of the emerging battery technology will also eliminate the environmental concerns caused by using disposable $LiSO^2$ batteries. Existing technology and research is deficient and have not been focused on small air platform applications in regards to reduced weight, smaller volume, high energy/power density, recharageability, handling safety, and long operating life.

PHASE I: Investigate the emerging rechargeable battery technology which can provide high energy/power density for small air platform applications. Conduct a feasibility study and perform hardware design, technology tradeoffs, and performance analysis.

PHASE II: Develop prototype hardware, and demonstrate a lightweight rechargeable battery pack with high energy/power density for small air platform applications.

PHASE III: Produce the advanced rechargeable battery system for integration on small air platforms and subsequent operational testing.

COMMERCIAL POTENTIAL: The lightweight, high power/energy density rechargeable battery for robotic vehicles applications has many commercial applications, including portable electronic equipment, wireless communications networks, mobile phones, portable facsimile machines, and personal computers, etc.

N95-020 TITLE: Solid State Pulsed Power Driver

OBJECTIVE: Develop a compact, all solid state pulse power driver that produces fast risetime electrical pulses to multiple kilohertz repetition rates, for arclamp, flashlamp and plasma discharges application.

DESCRIPTION: A wide variety of commercial and military application exist for pulsed power drivers that are capable of delivering fast risetime, high peak voltages and current pulses to gas-dynamic loads at high pulse repetition rates. Typically, these rates can range from a few hertz up to 20 kilohertz depending on the specific application. The most notable applications involve coupling high power pulses drives to high pressure arclamps and flashlamps, or to low pressure plasma discharge cells, to generate intense optical emission. Additional applications for this technology can be found in the area of radar developments and utilization. An all solid state pulsed power driver would significantly improve the current state of the art in high power electrical switching by eliminating the need to use gas-filled thyration as high power switching elements in the circuit. The elimination of these devices could result in the development of a compact, high density driver suitable for airborne and remote ground-based systems (i.e., countermeasures against infrared guided missiles). Considerations should be given to an initial design concept that can provide pulsed energies up to 1.0 joules at a peak voltage of up to 20 kilovolts into a primarily inductive load imposed by a longitudinal discharge tube. The driver would produce electrical pulse risetimes of less than 30 nanoseconds (10% to 90%) at the load and should operate at pulse repetition rates of up to 10,000 pulses per second continuously with an operating lifetime of more than 10^{11} shots.

PHASE I: Show feasibility of the concept.

PHASE II: Demonstrate the product.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: The all solid state, pulsed power driver will have extensive applications potential in the areas of arclamp, flashlamp and plasma discharge ignition and operation, compact radar system design, high intensity light generation and electrical power control and distribution. When this pulsed power driver is applied to excitations of solid state lasers, the specific commercial applications include laser medicine (particularly laser cholercystectomy and dental lasers) laser metal working)

PRODUCT AREA: Training and Simulation

Training and Simulation technologies are responsible for developing synthetic environments to support initial requirements analysis and system development decisions for improved operational and affordable naval aviation systems.

N95-021 TITLE: Virtual Reality

OBJECTIVE: Develop virtual reality technology for military applications.

DESCRIPTION: Virtual reality is becoming increasingly important as a tool to provide cost effective alternatives for training and to provide enhanced capabilities for activities such as intelligence gathering, design and test and evaluation. However, much work needs to be done to refine and enhance our ability to portray the virtual environment so that its full potential can be realized for use in these and other military applications. The Navy will provide a minimum of two awards from quality proposals from the total proposals received from this topic:

Acoustical/tactile modeling: Methods need to be developed to more accurately simulate the actual characteristics of acoustic/tactile interaction with the virtual environment.

Data compression techniques: High fidelity, near real-time visualization of terrain over large, seamless geography requires enormous amounts of data. High fidelity compression techniques which increase storage capacity and rapidly transfer compressed data from storage to rendering processes are required in order to deal with the processing of real time updates of information.

Enhanced capabilities for 3-D rendering: Methods which address the requirements for three-dimensional (perspective) rendering (e.g., subpixel edge preservation during pixel magnification, space-variant resolution to match the resolution characteristics of the eye and motion) are needed to improve quality of image rendering.

3-D Imaging.

Material Classification: Automatic or semi-automatic methods for the classification of terrain surface materials based on their reflectance, thermal, emissivity, texture, surface projection and other properties of material are needed in order to enhance the prediction of visible spectrum, infrared (FLIR) and synthetic aperture (SAR) scenes.

Threat Vulnerability: Ever increasing complexity in threat environments requires new methods to dynamically display these threats. Threat characteristics which should be accounted for include aspect ratio and physical attributes as well as other parameters which are critical to aircrew warning.

PHASE I: Show feasibility of the concept.

PHASE II: Demonstrate the product.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Civilian applications abound for this technology.

N95-022 TITLE: Intelligent Interface for Mission Rehearsal

OBJECTIVE: To develop an advanced configuration for realistic, multi-platform mission rehearsal. Current approaches to distributed interactive simulation cannot support the Navy's need for shore-based or deployed mission rehearsal under the demands of actual sensor and crewstation environments. An advanced interface is needed to improve communication protocols by allowing aircrew operating from different simulated platforms to cooperatively preview and rehearse threat engagements.

DESCRIPTION: In combat, aircrew must perform situation assessment under time-compressed data-intensive conditions, coordinate control action with other fleet assets, and minimize sensor and communication emissions. An intelligent interface capable of supporting networked, high fidelity, multi-platform aviation simulations in a realistic sensor environment is required for improved mission rehearsal. This intelligent architecture must consider the multi-sensor capabilities of different platform types and effectively transmit information on the tactical picture to other platforms. The human-system interfacing strategies which allow for cooperative interaction of operators and instructors/system managers (real or artificial) must not require extensive modification or disruption to actual cockpit displays/controls or exceed the capacity constraints of system mission computers.

PHASE I: Provide a report detailing the critical concepts and design features necessary to implement and demonstrate the intelligent interface for single and multi-platform mission rehearsal systems.

PHASE II: Demonstrate and evaluate the effectiveness of incorporating an intelligent interface in both single and multi-platform mission rehearsal systems. The networked mission rehearsal system design will be demonstrated using two or more simulations of dissimilar tactical aviation platforms.

PHASE III: Transition to ongoing and planned Navy and Air Force programs.

COMMERCIAL POTENTIAL: The various features of the operator and system manager-in-the-loop rehearsal system could be easily adapted and used to advantage by commercial airlines in support of cockpit resource management (CRM) training programs. The design concepts could also be extended to commercial shipping interests to support cross-positional and situational awareness training.

N95-023 TITLE: Automated Feature Extrusion for Photo-real Perspective Scenes

OBJECTIVE: To develop techniques to automatically extrude man-made and natural photo-image features for realistic dynamic low altitude rendering.

DESCRIPTION: Photo databases are used for a wide range of applications: intelligence, mission preview, planning, rehearsal and training systems. The DOD has acquired the imagery and created photo-real databases that cover vast land masses throughout the world. While these existing databases are valuable for high altitude applications, their utility for low altitude (e.g., helicopter applications) is severely limited. Current techniques to extrude the features which gives the terrain a realistic appearance when it is viewed from ground and near ground level requires significant amounts of time for even modest figures. Automated methods and tools are required to increase the efficiency of, and reduce the time required for, the feature extrusion process.

PHASE I: Provide a report describing the methodology to extrude man-made and natural features in a photo-real database that increases throughput by at least five fold.

PHASE II: Develop, test and operationally demonstrate the feature extraction method formulated under the PHASE I SBIR effort and demonstrate its effectiveness for both shore-based and on-board mission planning and rehearsal systems.

PHASE III: Transition to ongoing and planned Navy and Air Force programs.

COMMERCIAL POTENTIAL: The techniques developed under this effort would greatly enhance the value of satellite and aerial photography data for use in Virtual Reality location-based entertainment and interactive educational applications.

N95-024 TITLE: Quick Response Terrain Visualization

OBJECTIVE: To develop techniques to support the use of raw imagery data for terrain visualization.

DESCRIPTION: Photo databases are used for a wide range of applications: intelligence, mission preview, planning, rehearsal and training systems. Current methods vary greatly in the time it takes to prepare the terrain database and to update these databases when new imagery is received. Much of the time processing this data is spent geo-correcting the data using ortho-rectification and "rubber sheeting" techniques. Methods and processes are needed to reduce these time consuming processes to provide realtime databases for photo-real perspective scene generation.

PHASE I: Provide a report detailing the design features necessary to implement realtime data processing to produce a 60 mile, 10-meter (or better) resolution database from raw satellite or photo-imagery and digital terrain elevation data (DTED) in less than 30 minutes.

PHASE II: Develop, test and operationally demonstrate the Quick Response Terrain Visualization method formulated under the PHASE I SBIR effort and demonstrate their effectiveness for both shore-based and on-board mission planning and rehearsal systems.

PHASE III: Transition to ongoing and planned Navy and Air Force programs.

COMMERCIAL POTENTIAL: The technique developed under this effort would be applicable to satellite and aerial photography data processing and related photogrammetry.

N95-025 TITLE: Real Time Image Compression with Edge Feature Retention for Use During Airborne Reconnaissance

OBJECTIVE: Devise a concept for "real time" compression of video imagery collected during airborne reconnaissance which, when decompressed, maintains the textures and edges of the original image.

DESCRIPTION: A proof-of-concept is sought that demonstrates real time compression (and subsequent fast time decompression) at a rate of 30 video frames per second. The technique must maintain image quality for subsequent image enhancement and automated computer processing. The image compression/decompression techniques examined in PHASE I of this SBIR must be compatible with a real time digital communication error detection and correction (EDAC) scheme and extensible to larger 1024 x 1024 pixel video images. Absolute preservation of edges is a mandatory requirement. However, an extremely high compression ratio (>20:1) is desired. The image compression/decompression technique must be applicable to up and down linked satellite communication (6 MHz bandwidth) or the 7 Mhz bandwidth Modular Interoperable Data Link (MIDL) relay of color video images or second generation imaging IR (IIR) video images.

PHASE I: Define "real time" image compression/decompression algorithms (or techniques) applicable to color National Television Systems Committee (NTSC) video with fixed backgrounds and no foreground object movement. PHASE I efforts should also examine the applicability to 256 x 256 pixel imaging infrared (IIR).

PHASE II: Demonstrate real time image compression/decompression algorithms (or techniques) applicable to color NTSC video with fixed backgrounds and no foreground object movement. PHASE I efforts should also examine the applicability to 256 x 256 pixel imaging infrared (IIR).

PHASE III: PHASE III efforts should examine the application of the image compression, processing and error control technique to both military seekers and to digital (Advanced Television Research Consortium) high definition television (HDTV) video format images with fixed background/foreground; or, (b) fixed background/moving foreground objects.

COMMERCIAL POTENTIAL: Transmission of high definition television (HDTV) video images using conventional broadcast equipment and higher capacity on cable transmission systems.

N95-026 TITLE: Spatial Acoustic Sound for Virtual Environment Applications

OBJECTIVE: Develop digital hardware and software technology to provide flexible, realistic, localized sound for use with virtual environment applications.

DESCRIPTION: The two primary techniques for spatial sound production involve the use of either external speakers or headphones. The pitch and volume of a sound sample can be sliced and placed within a cube of speakers to produce the illusion of localized sound. This method, however does not account for the acoustic properties of the physical space, and therefore, can be relatively coarse. It is predominantly used for applications with many simultaneous users of systems where the user cannot be required to wear a device. The alternative is to localize the sound using a head-related transfer function and manipulate the sound sample with respect to the human head. Recent systems are extremely limited in both the number of simultaneous sound-emitting sources and the quality and fidelity of the sound itself. Current needs and requirements call for a digital hardware and software technology solution which is capable of real-time computation and manipulation of the sound taking into consideration all acoustic effects such as Doppler shift and reflectance. The device must be fast (able to synchronize with real-time computer graphics) and flexible. Typical virtual environment systems prefer a headphone-based system due to their single-user nature.

PHASE I: Provide a thorough investigation of possible solutions which address the needs and requirements listed above. A report describing the proposed solution, its technological improvements over past solutions, and its expected performance specifications will be required.

PHASE II: Develop, test, and demonstrate the solutions described under the PHASE I effort.

PHASE III: Produce the system developed under the PHASE II effort.

COMMERCIAL POTENTIAL: Spatial sound systems are a necessary component of all virtual environment applications. Their development will encourage wider use in creating more effective virtual environment systems.

N95-027 TITLE: Referee Receiver Processing System

OBJECTIVE: Develop digital receiver technology which provides for real-time determination of electromagnetic ground truth during the conduct of at-sea/range testing of Electronic Warfare (EW) and missile systems.

DESCRIPTION: The Navy conducts extensive flight tests to evaluate the performance of EW and missile systems. The requirement to test in a realistic environment often places a considerable demand on range instrumentation use to collect data for test reconstruction. Analysts must carefully reconstruct the test environment in order to determine the overall effectiveness of the system under test. Develop digital receiver technology featuring Surface Acoustic Wave (SAW) devices and high speed R-to-D converters to enable high fidelity processing of the electromagnetic signal spectrum. The processed data is to be time tagged and displayed, both, spectrally and temporally. The system would serve as a referee to independently document the responses of the system(s) under test.

PHASE I: Upon examination of appropriate test plans for conducting at-sea tests of EW systems against antiship missile simulators, develop a conceptual approach using modern receiver and processing technology to record the electromagnetic spectrum present in this environment. The relatively low signal density provides an opportunity to employ analytical techniques which permit accurate reconstruction of the jamming signal's spectrum as well as that of the missile seeker's radar. Interfaces to other instrumentation and reference sources is also required for accurate events reconstruction. A report defining the requirements, potential solutions, tradeoffs and recommended technological approach being considered shall be required.

PHASE II: Based on the results available from the PHASE I study and subsequent review by personnel from the Navy's T&E community; develop, the receiver technology for evaluation in an actual test situation and demonstrate the benefits derived from the addition of this capability into the test environment.

PHASE III: The technology and modular design approach demonstrated in PHASE II of this SBIR would be available for incorporation into range instrumentation packages used throughout DOD's T&E community.

COMMERCIAL POTENTIAL: The increased use of the electromagnetic spectrum creates the necessity to cost effectively monitor the frequency spectrum for signal quality and compliance with established standards. This technology, developed from a modular perspective, could be tailored to support non DOD agencies in insuring proper use of the spectrum.

PRODUCT AREA: Aircraft Systems and Support

Aircraft Systems technologies include Air Vehicles, Propulsion, Aircrew Systems, Materials, Structures and Shipbased Support Systems. Aircraft Systems for naval aviation differ significantly from those of other services in that they must operate in a maritime environment, including those conditions associated with the aircraft carrier and other air-capable ships. The environments include: corrosion/salt spray, deck and elevator space limitations, size/weight restrictions, longer missions, over and underwater egress and survivability, turbulence and deck motion, precision controls, shipboard electromagnetics, unique visual conditions, special night operations, high lift, low speed, rapid engine response, special landing gear, special supportability and maintainability considerations (no cranes, no ladders, self-contained repair, etc.) and general aircraft performance in these severe conditions. The components and systems developed must be affordable, sustainable and supportable. Goals in Aircraft Systems include: improved safety and effectiveness in launching and recovering sea-based aircraft, reduced cost of ownership and improved readiness, increased force mission capability, and increased operational effectiveness and more survivable aircraft.

N95-028 TITLE: Ceramic Fasteners for Aircraft Joining Applications

OBJECTIVE: To develop lightweight and durable fasteners for joining components made from graphite reinforced polymeric and ceramic materials with similar materials and with metallic materials on current and emerging aircraft which can be used in both high temperature regions and in applications requiring galvanic isolation

DESCRIPTION: Current practice is to use metal fasteners for structural joining in high temperature regions near aircraft engines. Metal fasteners are also used for joining graphite reinforced composite panels to galvanically dissimilar metallic components, where sealants are applied to the outer and mating surfaces of the metallic components for galvanic isolation to prevent induced corrosion. The purpose of this program is to develop alternative ceramic-based fasteners for replacing the metals fasteners on both of these aircraft joining applications.

PHASE I: Develop fastener design(s) suitable for both of these aircraft joining applications. Fabricate and test material system for demonstration of improved galvanic isolation properties to those of current fastener design.

PHASE II: Develop and fabricate prototype ceramic fasteners. Demonstrate the capability of the new fasteners to replace existing fasteners. Assess the benefits of using ceramic fasteners and develop a manufacturing plan.

PHASE III: Produce the hardware demonstrated in PHASE II.

COMMERCIAL POTENTIAL: Ceramic fasteners would find use in high temperature automotive and aircraft applications.

N95-029 TITLE: Aircrew Head Support

OBJECTIVE: Design, develop, fabricate and test an innovative device which will provide support to the neck and head to markedly reduce the maneuvering and ejection loads on the aircrew's cervical spine.

DESCRIPTION: The vertebrae are the most frequently injured body part in naval ejections over the past 20 years. The cervical spine supporting the neck, head and all head supported weight has proven to be particularly vulnerable. In fact, serious cervical and spinal cord injuries have resulted from otherwise benign ejections. Unless positive solutions are found, the frequency of vertebral injuries will increase in the future due to operating in and ejecting from highly maneuverable, dynamically unstable, aircraft. This condition will be aggravated in combat when urgency of ejection will preclude removal of the night vision equipment prior to ejection.

A neck and head support system would decrease ejection injuries when wearing the added head supported weight of night vision capable systems. Reference (1) describes how the spine can remain uninjured during spinal compression and bending. Since the ejection seat acceleration is constant, weight added to the head can produce sufficient compression and bending forces in the spine to cause injury and fatality. One method proven successful, using inflatable bladders, has been used on human ejection tower tests to control head rotation and assure correct axial spinal loading (Reference (2)). In rotary wing and non-ejection seat equipped fixed wing, where crash survivability is required, the Inflatable Body and Head Restraint Systems (IBAHRS) technology (Reference (3)) is a potential approach used. The IBAHRS system inflates bladders, when a crash pulse is sensed, to provide crash protection by limiting the rotation of the head and torso.

PHASE I: Provide a thorough operations analysis to define the aircrew head support problem and establish the operational criteria and design and performance requirements. Accomplish a trade study leading to a selected design approach. The study must include in-flight performance, protection during ejection, weight, cost, environmental effects, as well as,

materials, manufacturing and logistic support considerations. Based upon this work, conceive a design and complete a preliminary design of the proposed solution.

PHASE II: Complete a prototype design and conduct critical experiments and feasibility testing to verify the concept and its ability to perform as required by the operations analysis and other criteria identified in PHASE I.

PHASE III: Complete the design and fabrication and conduct development testing.

COMMERCIAL POTENTIAL: This work can produce advanced improvements for automobile crash protection, sports injury protection and crash impact protection for the general aviation industry.

N95-030 TITLE: High Speed Three Dimensional (3-D) Scanning of Complex Air Flow Fields

OBJECTIVE: Increase the area mapping capability of light detection and ranging (LIDAR) based remote wind sensors.

DESCRIPTION: The airwake velocity field in the aircraft recovery envelopes for aviation capable ships is extremely complex. Turbulent vortices generated by the ship's superstructure change direction and intensity with the magnitude and direction of the wind over the deck (WOD) as well as with ship motion. This complex flow field directly affects the pilot's control of the helicopter on approach, hover, landing and deck operations. This problem is further complicated by the addition of flow disturbances caused by the aircraft. The Navy is currently developing a LIDAR which is capable of measuring the wind that aircraft encounter along the approach and recovery flight paths and directly over the flight deck. Performance and accuracy of current scanning methods are limited by wind turbulence and size/type/orientation of the sensor. The Navy desires to investigate a scanning method which will operate at high speed and allow the shipboard LIDAR the capability of fully and accurately mapping a 100 x 100 x 50 foot area in real time.

PHASE I: Provide a feasibility study which develops a method for high speed 3-D real-time scanning of a shipboard LIDAR system. The study should investigate various processing techniques including digital and optical implementation. The study should also include a preliminary design of the system, including hardware.

PHASE II: Develop, test and operationally demonstrate the scanning system formulated under the PHASE I SBIR effort.

PHASE III: Integration into the Navy's LIDAR wind sensor and test of the fully integrated operational system on a Navy ship.

COMMERCIAL POTENTIAL: New concept can be incorporated in all LASER remote wind sensors including those employed in civil/commercial aviation by the FAA to detect wind shear and microbursts.

N95-031 TITLE: Innovative Small, Heavy Fuel Engine Concepts

OBJECTIVE: To examine breakthrough, state-of-the-art, innovative small heavy fuel engine concepts to determine feasibility of concept.

DESCRIPTION: The DOD desires to consider advanced innovative small internal combustion engine concepts that will advance the present state-of-the-art (power to weight) in the 25-100 horsepower range, with applications including unmanned aerial vehicles, generator sets and portable fire pumps. Innovative concepts and design shall focus on both diesel and JP-8 fuel (heavy fuel) operation and lightweight construction. Engine concepts shall have power to weight ratios approaching 1.0 and brake specific fuel consumption not exceeding 0.7 lbs/hp-hr.

PHASE I: Conceptual designs shall be generated and validated through theory, analysis and subscale testing.

PHASE II: Fabrication of full scale designs and experimental verification of the concept.

PHASE III: Produce limited numbers of pre-production engines for field demonstrations and validation.

COMMERCIAL POTENTIAL: Numerous uses of small gasoline engines would be replaced by equivalent performing diesel fuel engines that are inherently safer.

N95-032 TITLE: Next Generation Electrolytes for Use in Electrochemical Machining (ECM)

OBJECTIVE: Use new/advanced electrolytes in ECM technology to address (and hopefully achieve) significantly increased material removal rates, increased precision, improved finish rates, lower power consumption, improved environmental compatibility both in terms of lower health hazards for the ECM operator and reduced waste products while lowering machining costs.

DESCRIPTION: Electrochemical machining (ECM) is a relatively nontraditional fabrication technique based on controlled removal of material by electrolytic dissolution of the work piece. In ECM, the metal removal rate is independent of the relative hardness of the part and the tool. Air-breathing propulsion materials (such as titanium and nickel aluminides) used in Navy aircraft jet engines are becoming harder and more brittle and thus are more difficult to machine using conventional methods. The ECM process, despite its advantages, has had limited applications due, in part, to a lack of to a broad range of electrolytes. Electrolytes currently in use include aqueous solution of salts or strong hydroxides. Electrolytes serve several purposes: (a) carry the electric current between the tool and work piece, (b) heat removal and (c) remove reaction products from the cutting region. Until recently, there has been a lack of scientific understanding of the work piece/electrolyte interface phenomena. Proposals are sought to identify and investigate the use of advanced electrolyte systems (such as, but not limited to, molten salts or molten bases) as they apply to advanced gas turbine propulsion materials. Develop analytical projections for removal rates, precision, surface finish, reduced waste products for engine components made from advanced metal alloys and metal matrix composites.

PHASE I: Identify various electrolytes and indicate physical properties, demonstrate the advantages of each specific electrolyte for feasibility of its removal rate on a selected material, its industrial application and its cost-effective use. Identify associated operation and maintenance requirements. Demonstrate the ECM process using the proposed electrolyte(s) on a specified aircraft gas turbine material.

PHASE II: Develop, build, test and demonstrate a prototype ECM system capable of processing full-scale engine hardware. Demonstrate and optimize system parameters for use on selected advanced metal alloy, ceramic and metal matrix composite turbine components.

PHASE III: Produce a commercial ECM system based on parameters developed in the PHASE II SBIR effort.

COMMERCIAL POTENTIAL: ECM process can be used on both military and commercial aircraft engines as well as manufacturing heavy industrial hardware.

N95-033 TITLE: Structural Fatigue Assessment via NDT/I Techniques

OBJECTIVE: The objectives of this effort are to develop Non-Destructive Testing and Inspection techniques and methodologies in order to assess the state of structural fatigue in U.S. Navy aircraft.

DESCRIPTION: The U.S. Navy through its Structural Appraisal of Fatigue Effects (SAFE) program, for over three decades, has led the way by implementing state-of-the-art structural fatigue tracking systems to assess and manage the fatigue damage incurred by every one of its thousands of fixed-wing aircraft. Individual aircraft usage is recorded (with airborne equipment such as Counting Accelerometer Groups and multi-parameter recorders) and analyzed in conjunction with full-scale fatigue test results to determine the fatigue damage. The focus of this SBIR effort is to apply existing, or develop new, NDT/I techniques and methodologies to explore, identify, and seek to both qualitatively and quantitatively assess the state of structural fatigue damage accrued and stored in the material itself.

PHASE I: This phase will primarily focus on the applicability of various NDT/I techniques and methodologies to the structural fatigue assessment concept. Verification testing as required will be limited to coupons. PHASE I will produce a comprehensive report documenting (a) various options and approaches found to be feasible for achieving the goals of this effort, (b) the technical and economic risks associated with these options and approaches, and (c) a ranking of feasible options and approaches with justifying rationale.

PHASE II: After review of the PHASE I report, the Navy will direct the pursuance of selected option(s) and approach(es) in PHASE II. This phase will further develop the Navy-selected option(s) towards (a) investigating their scope of applicability and limitations for selected, typical structural details of designated Navy aircraft, and (b) establishing NDT/I-based fatigue life tracking parameters and procedures in support of Navy's SAFE program.

PHASE III: Upon a successful PHASE II completion, Navy-funded PHASE III effort is anticipated for the transitioning of the structural fatigue assessment NDT/I methodologies for utilization assessment with regards to the SAFE, SLAP (Service Life Assessment Program) and SLEP (Service Life Extension Program) elements of the ASLS (Aircraft Structural

Life Surveillance) program.

COMMERCIAL POTENTIAL: The effort is inherently extendable for commercial application, safety and success.

N95-034 TITLE: Durability Modeling of Fiber Reinforced Ceramic Matrix Composites

OBJECTIVE: Develop a methodology for predicting the durability of ceramic matrix composite materials and structures under the thermal, mechanical and environmental conditions expected in Naval aircraft.

DESCRIPTION: Ceramic matrix composites (CMCs) are a promising class of materials that can dramatically increase the thrust-to-weight ratio of the future Navy aircraft. However, the operating environment for Navy aircraft is very harsh and severe. Current development work shows that the CMCs are susceptible to hot corrosion attack. Near term applications for CMCs are in Exhaust components which operate in the hot corrosion regime.

The successful use of CMCs in man-rated Navy aircraft engines requires that the factors contributing to material degradation be recognized. Methods are required whereby these factors can be accounted for during the design and life management of these CMC components. The key issue is life prediction - in this case a model is needed for estimating the influence of operating environment on expected life of CMC components. Hot corrosion can significantly reduce the life of a CMC part. A durability model could also provide guidance to researchers for improving CMC environmental resistance (i.e., effect of coatings, matrix modification, etc.). The current life assessment methodology is based primarily on a limited set of coupon tests and full-scale engine tests. However, the development of a full data-base will be expensive, and time-consuming. A more cost-effective approach is to develop a predictive model for material durability based on a knowledge of the active degradation mechanisms of the constituent materials and their effects on the overall behavior of CMCs.

PHASE I: Provide a feasibility study on developing a durability model for a leading candidate CMC system such as SiC/C composites. The thermal degradation mechanism of the constituents (fiber, matrix, and interface) will first be identified based on the existing data base. The impact of each individual thermal degradation effect (e.g., fiber instability and oxidation of fiber, matrix and interface) on the overall composite performance will be formulated into individual thermal models with additional consideration of thermal cycling, and non-steady state thermal profiles. A micromechanics approach will then be used to integrate individual models into a combined thermal effect model. This model will illustrate property variation as a function of time, temperature, location, stress and environment.

PHASE II: Develop a full scale CMC durability model applicable to all the leading candidate CMC systems (e.g. SiC/SiC, SiC/glass-ceramics, SiC/Si-O-N-C) and validate model by an experimental test matrix. In addition to thermal degradation, corrosion/erosion degradation, mechanical degradation (such as creep, relaxation and damage), coating substrate interactions, local versus global coating failures will be included in the final model. Typical laminate configuration, thermal cycle and environment expected for applications, such as exhaust flap and seal will be used to demonstrate the model.

PHASE III: Transition the CMC durability model developed in PHASE II to Navy Laboratories and to engine manufacturers. This CMC durability model will enable Navy laboratories to establish a new and unique capability in predicting life cycle performance of CMC materials proposed for various high temperature propulsion applications. Engine manufacturers will also benefit from this model for screening CMC materials for engine components.

COMMERCIAL POTENTIAL: Design methodology developed under this effort will enable CMCs to be applied to gas turbine engines that are operated in a marine environment. These include gas turbine generators stationed along coastal areas and generators on commercial ships and commercial airline transport aircraft engines.

N95-035 TITLE: Acoustic Sensors Used for Gearbox Vibration Monitoring and Diagnostics

OBJECTIVE: Gearbox vibration monitoring and diagnostics has been traditionally accomplished using accelerometers as vibration sensors. Acoustic sensors would offer advantages over current hard mounted and location specific vibration accelerometers in use today. This project would demonstrate the performance, effectiveness and relative benefits of acoustic sensor technology used for gearbox vibration monitoring and diagnostics compared to that provided by vibration accelerometers.

DESCRIPTION: Both fixed wing aircraft and helicopters use vibration accelerometers as sensor inputs to support various vibration monitoring and diagnostics systems for maintenance troubleshooting. Commercial helicopter manufactures are now implementing Helicopter Usage Monitoring Systems (HUMS) that depend heavily on vibration accelerometer sensors for gearbox monitoring. The use of acoustic sensors instead of the current vibration accelerometers could offer some specific advantages

for all these applications. The project would investigate, define, and quantify the specific capabilities and advantages of acoustic sensors used for gearbox vibration monitoring.

PHASE I: Define requirements for system and demonstrate, in principle, the concept of acoustic sensor based vibration monitoring.

PHASE II: Acquire and analyze vibration data using an acoustic sensor based vibration monitoring system, real-time during gearbox seeded fault tests. Compare results with those achieved using the standard vibration accelerometers. Report on evaluation results.

PHASE III: Define and procure a fully integrated acoustic sensor driven gearbox vibration monitoring system for demonstration test on a SH-60 aircraft.

COMMERCIAL POTENTIAL: Application for both military and commercial aircraft use.

N95-036 TITLE: Advanced Turbine Exhaust Particulate Measurement System

OBJECTIVE: Develop an advanced, non-intrusive instrumentation system for the measurement of turbine engine exhaust particulates.

DESCRIPTION: The need to measure gas turbine exhaust particulates is important to naval aviation in two respects. First, increasing environmental regulations, such as the Clean Air Act, are making it more important to know and be able to assess turbine engine exhaust emissions. As the regulations become more stringent, they may affect the way the Navy currently operates and tests aircraft engines. The ability to measure particulates will assist in the assessment of the impact that current and future Navy aircraft engines will have on air quality. The ability to predict emissions will allow the Navy to tailor operations and/or testing such that environmental impact will be minimized. Secondly, exhaust particulates are directly related to plume visibility and therefore aircraft survivability. By knowing the size, number and distribution of the exhaust particulates, a good estimate of plume visibility can be made. Current particulate measurement techniques require direct sampling from the exhaust plume and are not very accurate. A non-intrusive system with the ability to accurately measure particulates under 0.02 micrometers in size and their distribution will allow better assessment of engine exhaust in a wide range of situations, such as on the flight line or in a test cell.

PHASE I: Conduct a 6 month study to assess the ability to accurately measure engine exhaust particulates in a laboratory setting. Document findings in a final report.

PHASE II: Further develop the instrumentation system such that measurements can be made in the field with a minimum of special set-up and support equipment.

PHASE III: The system should be developed into a stand-alone, portable system capable of taking measurements in a wide variety of situations.

COMMERCIAL POTENTIAL: The measurement system would have application to engine and aircraft manufactures and the power generation industry.

N95-037 TITLE: Engine Composite Blade and Vane Repair

OBJECTIVE: Develop a suitable repair process/equipment for engine foreign object damage (FOD) to composite blades and vanes.

DESCRIPTION: Composite materials are being applied throughout airframe structures to: reduce weight, increase strength, and increase corrosion resistance. The maintenance community was not prepared to provide the required support for these composite material applications. Composites are now being developed for applications to naval aircraft propulsion systems. One of the more near-term applications of this technology will be to use Organic Matrix Composites (OMC) and Metal Matrix Composites (MMC) to cold section blades and vanes. This area of the engine is subject to a great deal of repair actions resulting from FOD. With current metal blades, FOD is repaired through blending. Composites can not be blended by means of conventional techniques. A repair and an inspection/validation technique must be developed to meet this critical fleet need.

PHASE I: Investigate present repair methods for composites on aircraft structures. Characterize potential cold section composite applications for blade/vanes/ Assess present FOD repair limits. Define potential repair techniques/equipment (i.e., blend, tip grind, patch/fill repair, etc.) and their limits for composites with traditional and advanced blade configurations (i.e., hollow, 3-D, etc.). Also define an inspection process to validate the integrity of the repair. These new techniques should

provide repair capability to help maintain current engine availability levels and have both I-level and depot level applicability. Document findings in a final report. The contractor and the government shall agree upon which repair concepts will be developed in PHASE II.

PHASE II: Define specific procedures and develop prototype equipment to perform the required FOD repairs/inspection. Perform repair procedures on coupon specimens and verify structural integrity using these new procedures. Obtain a sample of specimens requiring a FOD-type repair and execute the series of techniques developed. Analyze results. Document findings in a detailed final report.

PHASE III: Based on the results of PHASE II, further develop this capability for actual fleet application.

COMMERCIAL POTENTIAL: Composite blade/vanes will be transitioned to commercial engines, therefore this effort will be directly applicable to the commercial sector.

N95-038 TITLE: Advanced Automatic Test System (ATS) Resources

OBJECTIVE: Investigate the feasibility of using a common set of ATS resources to determine ATS architecture suitability, capture test requirements information for test program sets (TPS) generation, and meet the requirements for high mobility/inter-operability to support rapid action force deployment operations.

DESCRIPTION: Individual service components currently use unique, parametric-driven data systems to determine ATS architecture suitability requirements for weapon system support. Given the current ATS Investment Strategy to leverage ATS investments across DOD components, there is an increasing need for a common software tool to improve the selection, programming, enhancement and cost effective application of common ATS components. In addition, TPS development continues to be an exceedingly high cost/labor intensive effort and the evolving defense environment continues to demand high mobility ATS. This effort will investigate the feasibility of increased commonality and automation to improve weapon system support and reduce life cycle support costs.

PHASE I: Provide a feasibility study which determines the most appropriate design architecture and computer-aided software engineering (CASE) methodologies to capture test requirements information and accomplish ATS requirements determination analysis, TPS retargeting, and meet the demand for high mobility ATS support. The proposed approach should be a modular, open architecture design to facilitate upgrades, integration and inter-operability with designated common ATS resources.

PHASE II: Based on the successful completion of PHASE I, develop, test and operationally demonstrate the design architecture formulated under PHASE I SBIR effort.

PHASE III: Produce the core software/hardware technologies demonstrated in the PHASE II effort.

COMMERCIAL POTENTIAL: New tools/methodology can be used in a wide range of aerospace, commercial aviation and other commercial sectors.

N95-039 TITLE: Automated Composite Scarfing/Step Machining Apparatus for Curved Structures

OBJECTIVE: Design, develop, and fabricate an automated scarfing apparatus for repair of curved composite structures.

DESCRIPTION: Typically the contours of composite aircraft structures are complex in that the surface contains curvature in two planes. Currently available equipment is unsuited for the required tasks of scarfing the laminate to produce a well tapered, bounded repair joint. A device is needed which will adapt to this complex surface. This device should be capable of machining the laminate to a predetermined scarf angle and shape.

PHASE I: During PHASE I of this effort, deficiencies with present equipment will be investigated and a preliminary design concept developed and documented in a final report.

PHASE II: Additional development, fabrication and testing of this equipment will be performed in PHASE II.

PHASE III: Upon successful completion of PHASE II, produce the equipment for commercialization.

COMMERCIAL POTENTIAL: Use of composite materials in the commercial markets is vastly expanding. Apparatus developed under this SBIR has direct application to composite used in aircraft and auto industries.

PRODUCT AREA: Weapon Systems

N95-040 TITLE: Weapon Systems Improvements

OBJECTIVE: To improve weapon systems.

DESCRIPTION: The Navy requires improved weapon systems that must operate in the unique carrier environment, which is characterized by salt spray, ships' exhaust gases, intense electromagnetic fields, high (but not low) climatic temperatures, constant high wind and catapult takeoff/arrested landing. They must also be completely self-contained because on a carrier there is no room for weapons over 180 inches long, weapon maintenance, special purpose weapons, fragile weapons, unsafe weapons, special purpose pods, etc. Improvements may include reduce cost, precision targeting of targets in clutter, highly agile airframes, off axis targeting, real time precision strike and battle damage assessment, increased probability of kill warheads, automatic target recognition capability, enhanced adverse weather capability and reduced launch constraints. These improvements support Joint Strike, Air Superiority, and Joint Littoral missions.
To meet these goals the Navy is looking for innovative solutions which promise measurable improvements in any (or all) of the above areas. The Navy will provide a minimum of two awards from quality proposals from the total proposals received from this topic:

PHASE I: Show feasibility of the concept.
PHASE II: Demonstrate the product.
PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: The technologies developed should have applicability to the civilian market.

N95-041 TITLE: Sensitive Uncooled Micromechanical IR Detector

OBJECTIVE: To decrease the cost, complexity and weight of sensitive IR detectors.

DESCRIPTION: Sensitive infrared detectors must be cooled and this requirements adds considerable cost, complexity and weights to infrared systems. If sensitive uncooled detectors could be developed, the number of applications both military and commercial would increase significantly. The recent development of a micromechanical calorimeter has shown the possibility of using this type of technology as a sensitive uncooled infrared detector.

PHASE I: Provide a feasibility study to determine the possibility of using micromechanical devices as uncooled IR detectors. This study should identify and analyze the major problem areas associated with this technology.

PHASE II: Develop and demonstrate a prototype infrared detector and show haw the major problems identified in PHASE I were approached.

PHASE III: Produce the infrared detector.

COMMERCIAL POTENTIAL: This innovation has potential to decrease cost of this technology used in infrared imaging and diagnostics.

N95-042 TITLE: Environmentally-Durable, Electrically-Conductive Coatings for High Speed Aircraft Windows and Missile Domes

OBJECTIVE: Erosion and thermal-shock resistant, electrically-conductive, optical coatings for MWIR (3 to 5 microns) and/or LWIR (8 to 12 microns) high-speed missile domes and aircraft windows.

DESCRIPTION: Fabricating adherent coatings that can endure severe environments and provide the necessary elector-topical performance is recognized as a major problem in commercial and military applications. For example, advanced dome materials like sapphire will need further processing and/or special conductive coatings to meet anticipated high-speed missile requirements. current RF/EMI shielding and mitigation techniques have limited success. Conventional, conductive metal mesh structures on external surfaces reduce the RF signal but are mechanically soft and easily damaged. surface-doped semiconductors such as gallium arsenide have optical absorption and emission problems. Durable, adherent, electrically-conductive coatings are needed.

PHASE I: Identify promising materials and coatings processes. Fabricate witness samples of the most promising

materials for preliminary characterization of elector-optic performance and evaluation of erosion-resistance.

PHASE II: Demonstrate a cost effective, large area, uniform coating process for simple and complex shapes. Provide samples for validation testing of elector-optic performance and impact resistance.

PHASE III: Production capability for depositing electrically-conductive, durable, optical coatings on missile domes and aircraft windows.

COMMERCIAL POTENTIAL: Similar technology is required for optics, sensors, and photovoltaic arrays on commercial satellites where electrical charging and space-debris/micrometeroid-impact damage severely limit the useful life-cycle. Durable coatings are needed for fiber optic sensors used in severe chemical environments such as automobile and industrial pollution monitors. Electrically-conductive, durable coatings could be used to provide lightweight EMI shielding in many commercial products where electronic noise is a problem.

N95-043 TITLE: Wavelet Transforms in Electronic Warfare (EW) Signal Processing

OBJECTIVE: Develop Wavelet Analysis as a new approach to Modulation On Pulse (MOP) processor capabilities and significantly enhance EW System identification.

DESCRIPTION: EW System Emitter ID is currently performed using classical emitter parameters. In addition, MOP is also used particularly in problems involving the following conditions:

1. Emitters with similar parameters
2. Emitter parameters with time variation
3. Signal multipath environments
4. Other real world environments.

The use of MOP signals have added significant performance to ID results and Wavelet processes promise to be ideally suited to these signals. This method is capable of giving signal information in both the time and frequency domain.

PHASE I: Conduct a 6 month study to assess the Wavelet Transform approach to give increased precision to radar system identification by characteristic MOP. The detection ability will be compared with that using the Fourier Transform. Document findings in a final report.

PHASE II: A description of the processing of true raw data in a hardware-software system will be given.

PHASE III: Transition to a Navy airborne EW system.

COMMERCIAL POTENTIAL: The technology developed here has application in the private sector in the analysis of cardiology signals, in compacting TV data, and GPS.

N95-044 TITLE: Increasing Frequency Coverage Of High Temperature Superconducting Antennas for VHF/UHF Applications

OBJECTIVE: Increase the frequency coverage of high temperature superconducting (HTS) antennas in the VHF/UHF frequency bands.

DESCRIPTION: The Navy's current interest in the VHF/UHF frequency bands focuses on antiradiation missile (ARM) seekers, air-intercept missile (AIM) seekers, communication data links for aircraft, weapon, and submarine applications. The available antenna aperture for these platforms is severely limited as compared to the operating wavelength. High temperature superconducting antennas and superdirecting arrays of HTS antennas offer the potential for increased directivity and efficiency on small platforms. However, these improvements are gained at the expense of instantaneous bandwidth. Therefore, before the advantage of HTS antennas can be realized in these Navy systems methods for increasing the frequency coverage of electrically small HTS antennas need to be developed.

PHASE I: Identify and compare potential methods for increasing the frequency coverage of electrically small HTS antennas. Provide a feasibility study which quantifies the increase in frequency coverage as well as potential reductions in overall directivity and efficiency, increases in size, weight and volume effects on pattern fidelity. Compatibility with HTS materials processing and methods of cryogenic cooling should also be examined.

PHASE II: Develop, test and demonstrate an HTS electrically small antenna element with enhance frequency coverage using one of the methods identified in PHASE I.

PHASE III: Using HTS electrically small antenna element with enhanced frequency coverage developed in PHASE

II, develop and test an array for limited aperture platforms.

COMMERCIAL POTENTIAL: Commercial applications for compact arrays of HTS VHF/UHF antennas include global communication systems.

N95-045 TITLE: GPS CCM Improvements

OBJECTIVE: Improve air-to-surface weapon GPS jamming resistance at a range of 8 nm or greater.

DESCRIPTION: The Navy is currently developing weapons that rely on GPS data for target location and as an aid to INS guidance to the target. This SIR project will improve the weapon's resistance to jamming until its terminal seeker takes over the guidance function.

PHASE I: Perform a feasibility study examining new technologies in antenna/receiver electronics, improvements in data processing, and more efficient algorithms to determine the cost effectiveness of improving GPS jam resistance for precision guided munitions.

PHASE II: Develop and demonstrate the proposed improvement. Perform a production cost estimate.

PHASE III: Package improvements into a missile compatible size. Perform a flight demonstration on a transition candidate, such a JSOW P3I.

COMMERCIAL POTENTIAL: Anti-terrorist protection in commercial air applications.

N95-046 TITLE: GPS Telemetry Transmitter

OBJECTIVE: Augment an existing telemetry (TM) transmitter with a Global Positioning System (GPS) receiver. The resultant transmitter will have the ability to transmit GPS-based Time-Space-Position information (TSPI) on a subcarrier of the normal TM data stream. The augmented transmitter will feature an output port so that the digital GPS data can be directed into the digital data stream. This augmentation shall not disable any of the current TM transmitter's capabilities and shall preserve the exact form factor.

DESCRIPTION: The missiles of the last 20 years have all been fitted wit telemetry packs that bring needed information down to range personnel for further development or t\for test and evaluation. These telemetry packs have TM transmitters as subsystems. within. The requirement is to develop a TM transmitter that has its current capabilities and will have GPS embedded within to be sent down in one of two ways:

1. Via standard TM channel
2. Via sub-carrier in the TM frequency

The GPS information would provide tracking information that would meet missile test requirements.

PHASE I: Identify components and interfaces of the elements of TM transmitters to meet the above needs.

PHASE II: Design, fabricate and test a breadboard design of a GPS TM transmitter including GPS antenna on a missile.

PHASE III: Design fabricate, and test five prototype TM transmitter and document the design for transition into production program.

COMMERCIAL POTENTIAL: The technology has application in the private sector where small GPS sensors are needed. When interfaced with new or existing communication links, this technology would provide long distance, precise position information to central control centers on aircraft and commercial land vehicles for many functions including: emergency search and rescue location, crash location, and traffic control.

N95-047 TITLE: Arrays of Conformal Waveguide

OBJECTIVE: Develop a low cost accurate array of conformal ridge waveguides.

DESCRIPTION: There is an immediate need for a low cost accurate, compact planar antenna array and the required circuitry to be applied to fuse and seeker antennas. This technology can also be used to construct complex waveguide circuits. An

example of the fuse antenna would be for an air-to-air guided missile. Most fuse antennas are mounted on the sides of the missile and have an rectangular cross section. This reduces the antennas performance and takes up valuable volume in the missile. This technology can produce a low cost and high performance fuse antenna that conforms to the missile outer skin resulting in better electronic counter-countermeasure (ECCM) performance, lower sidelobe levels, lower cost, and lower volume.

PHASE I: Investigate the feasibility of constructing an array of conformal ridge waveguides side by side. The development will be done for the array of two waveguides.

PHASE II: Develop a prototype systems to demonstrate the array of multiple side by side waveguides performance. The waveguide array is an antenna system and its associated circuitry.

PHASE III: Integrate a prototype system into an actual air-to-air missile.

COMMERCIAL POTENTIAL: The commercial need for this technology is in the area of Direct Broadcast Satellite (DBS) receiving antenna and collision avoidance car antennas. Low cost and high volume is the greatest concern in these areas. The DBS antenna and the combining circuitry can be constructed from one sheet. The resulting antenna and circuit is on the same plane resulting in a high performance, low cost, and very producible product. An array of antennas with different RF views of the road in front can also be constructed using this approach.

MARINE CORPS REQUIREMENTS

N95-048 TITLE: Systems and Technologies for Future Amphibious Warfare

OBJECTIVE: To enhance Marine Corp's future amphibious warfare capabilities the following top level needs have be addressed; Surface Mobility Technology, Mine Detection Technology, Land Mine Countermeasures Technology, MARFOR C4I Technology, MAGTF Survivability Technology, Advanced Amphibious Logistics Technology, Targeting Sensors, Weaponry Technology.

DESCRIPTION: The Marine Corps is seeking new, innovative ideas in technologies or systems concepts that support the Marine Corps amphibious mission. A minimum of five awards will be made under this topic for quality proposals. Proposals may be submitted that fit the top level needs or specific subject areas and should be titled to allow identification by top level need or specific subject area title:

A. Top level needs

1. Surface Mobility Technology - Technologies which increase the overall capabilities of Marine Corps vehicles and surface mobility.

2. Mine Detection Technology - Capability of remotely detecting all types of land mines during operations from the very shallow water/surf zone to inland battlefields. Need is for real time, day/night detection and surveillance capability to remotely detect current and future mine threats.

3. Land Mine Countermeasures Technology - Technology for rapid neutralization of mines, mine fields, booby traps and other obstacles in the surface zone and ashore to include advance threat wide area mines.

4. MARFOR C4I Technology - Innovative technologies in electronics and information management processing to enhance and support Marine Force Command, Control, Communications, Computers and Intelligence to include revolutionary materials for advanced stored energy concepts.

5. MAGTF Survivability Technology - Technology which increases the survivability of Marine Corps personnel and equipment assets in all levels of combat and physical environments for the Marine Air-Ground Task Force (MAGTF)

6. Advanced Amphibious Logistics Technology - Logistics technologies to enhance and support Operational Maneuver From the Sea (OMFTS) concepts or improve or enhance all phases of logistics for Marine Corps amphibious operations for Combat Service Support of maneuver forces from minimum 60 miles at sea to up to 40 miles inland with no beach support area established.

7. Targeting Sensors - Innovative sensor technologies that enhance the engagement performance of direct and indirect fire weapons for the conduct of maneuver warfare by tactical ground commanders such as but not limited to early target detection, increased first round hit probability and successful Identification Friend or Foe (IFF) with passive/low signature methods.

8. Weaponry Technology - Technologies that focus on increasing the lethality and operational effectiveness of combat elements of the MAGTF such as but not limited to innovative technology for mounted mortars, enhanced target designation and volumetric lethality against area targets and advanced energetic material for multiple munitions use with significant weight reduction, but no loss of performance in company mortar system.

B. Specific Subjects

1. Wavelength-Selective Solar-Blind Filters - Development of wavelength-selective filters in the solar blind ultraviolet (UV) region.

2. GPS/GIS Based Engineering Reconnaissance in Support of Virtual Reality Presentations - Provide an Earth satellite based engineering reconnaissance data acquisition system that will support a virtual reality system for use by field commanders in making site selection decisions using the Global Positioning System (GPS) and the Global Information System (GIS).

3. Remote Display and Interrogator - The development of a wireless interrogator, which can be used in the field to obtain logistics data such as with a wireless helmet mounted device, which provides real time virtual supply information.

4. Container manifesting system - Development of an RF container manifesting system with a Manifest Tag and an RF label.

5. Light Weight Shaped Charge Case - Development of a shaped charge case that weighs significantly less than the traditionally used metallic cases with performance comparable to metallic case shaped charges.

6. Next Generation Batch Liquid Containers - Development of batch liquid containers, which are multipurpose, ballistic resistant and fire retardant.

7. Next Generation Field Transportable Liquid Transfer System - Develop fuel efficient, field transportable liquid transfer systems, which are integral to the container they are filling/draining.

PHASE I: At the end of a six months effort, work should have demonstrated the feasibility of a systems concept or technology, identified critical issues required to transition into the Marine Corps acquisition system, identified goals for systems performance, outlined the current technology maturity, provide evidence that the scientific principles on which the technology is based are sound and justify further work, identify the work necessary in a Phase II effort necessary to demonstrate technical feasibility and increase the potential of the technology or systems concept to transition in Phase III to public and private applications with an exploration of dual use potential.

PHASE II: At the end of a two year effort, the technology or systems concept must have been developed enough to bring subsystems or technologies for transition to maturity, completed sufficient work to enable the technology to transition to an active development program, or become the basis for an operation requirement and acquisition of the technology or subsystem for Marine Corps applications and or other service applications as well as private sector commercialization.

PHASE III: Phase III must include both public and private sector commercialization with a goal to reduce acquisition cost for Marine Corps through other service/government agency applications, as well as private sector commercialization. The ability to successfully transition in Phase III will be critical both in Phase I selection and Phase II approval.

NAVAL SEA REQUIREMENTS

In general Naval Sea Topics are more specific in their description. Content of Proposals responding to these topics shall be directly relevant to the topic title and topic objective and shall address major issues cited in the topic description section(s).

The following three topics solicit Phase I SBIR Proposals for the purpose of improving US Navy control of the air battlespace above land and sea as described. Theater Air Defense neutralizes enemy offensive projection of power in littoral regions with minimum casualties. The following technologies support these capabilities: missiles, surveillance sensors, and their signal processing; intelligence gathering; command and control; communication and other weapons for attacking enemy air targets.

N95-049 TITLE: Develop Naval Gunfire Defense against Anti-Ship Missiles

OBJECTIVE: The objective of this effort is to permanently defeat modern anti-ship Missiles by rounds or payloads that are fired from the Navy's standard five-inch gun. Existing active or passive countermeasures can temporarily distract or divert anti-ship missiles from their original target(s) and these capabilities are excluded from our objective. Although munitions employing thermochemical means have an expected high probability of success, and are preferred, other means may be proposed subject to the following requirements or restrictions.

DESCRIPTION: Relevant proposals shall provide an effective means to permanently defeat or kill anti-ship missile; the means will prevent the missile from re-engaging any Target. The proposed means should: Immediately cause mechanical damage/erosion of the missile structure or otherwise immediately defeat the missile's ability to engage the target(s); provide uncompromised use of the Navy five-inch gun; and provide new or modified five-inch munitions effective against modern anti-

ship missiles.

PHASE I: Relevant Phase I (concept definition) proposals shall: develop the design concept and physical characteristics and performance objectives of the munitions/disclose the aforementioned; provide calculations of kill probability as a function of the engagement geometries, timing/fusing, and the munitions expansion characteristics; and provide a demonstration of the concept in a ground test of a prototype munitions under static conditions.

PHASE II: Relevant Phase II (concept demonstration) proposals shall: conduct a twenty-four month effort including design and test of the munitions; conduct a critical design review of the munitions; effect the development of the munitions and perform field experiments against typical IR and RF seekers; submit the munitions design disclosure data for approval; and prepare test plans and test reports and execute all tests required.

PHASE III: Relevant Phase III (concept implementation) proposals shall: transition the technique to a government owned full scale item development and limited production. The sensor blinding metal vapor canisters will be tested and compared against other competing concepts.

COMMERCIAL POTENTIAL: The technology has applications in the private sector for metal coatings of wider availability and lower cost. Refractory metal coatings are needed in high temperature commercial processes and for oxidation (erosion) protection rocket nozzles.

N95-050 TITLE: Simulation of Optical Environmental Effects

OBJECTIVE: The objective of this effort is to develop techniques for the convenient simulation of optical environmental effects along the optical propagation path in Navy optical systems. Many Navy optical systems employed in detection, recognition, tracking, threat categorization, or countermeasures are sensitive to environmental effects along their optical line-of-sight.

DESCRIPTION: Relevant proposals shall provide an effective means to simulate optical environmental effects known to degrade the optical line-of-sight employed in Navy optical systems. These environmental effects, from whatever source(s), introduce distortion(s) into the propagating optical wave which observationally leads to effects such as scintillation, signal fading, beam steering, and image wander and distortions. These effects can inhibit the effective operation of an optical system resulting in reduced performance, at times, to unacceptable levels. Over the past several years, the Navy has developed and implemented a number of tools including laboratory hardware-in-the-loop simulations to evaluate the performance of various optical systems and techniques. To quantify the effects of the optical environment, methods for adding these effects to the optical system performance test are desired. An acceptable simulation must be well characterized, controllable, repeatable, and traceable to conditions encountered in field tests and demonstrations.

PHASE I: Evaluate various methods for simulating optical environmental effects. Select and recommend techniques which best meets Navy requirements for laboratory hardware-in-the-loop simulators.

PHASE II: Design, fabricate, and test an optical environmental effects simulator. Install equipment on a Navy hardware-in-the-loop simulator.

PHASE III: Multiple Government agencies develop, fabricate, and utilize optical systems which operate with turbulent paths. The availability of turbulence simulation hardware would be of value for the convenient testing of these systems. Similar uses on the commercial marketplace can also be identified.

COMMERCIAL POTENTIAL: The technology developed in this project could have application for the testing of commercial optical systems.

N95-051 TITLE: High Repetition Rate Mid-Infrared Lasers

OBJECTIVE: The objective of this effort is to develop a high repetition rate, high power, solid state laser to efficiently generate coherent energy in tunable wavelengths in the 3-5 micron range. The laser must be rugged and reliable and capable of being used in field testing.

DESCRIPTION: Relevant proposals shall provide high repetition rate, >30W output power lasers in the 3-5 micron range to support ongoing development of electro-optical systems. Electro-optical systems support improvement of capabilities in missile defense and surveillance sensors.

PHASE I: Demonstrate the feasibility of the proposed concept to improve power scaling and/or decrease cost of such lasers. A design concept shall be developed for the 30W output power laser.

PHASE II: Develop, fabricate, test and demonstrate a prototype high power mid-infrared laser suitable for overwater testing at a range. Laser tunability shall be demonstrated to be within atmospheric transmission subwindows.

PHASE III: The technology will be transitioned to a government owned test facility.

COMMERCIAL POTENTIAL: Other possible applications include the use of such a laser source for drug interdiction and oil exploration for sensing hydrocarbon molecules. The 1 micron diode pumped laser can be used in the semiconductor processing equipment market with a $1 billion sales potential.

The following six topics relate to submarines and requirements necessary to enable them to function effectively in the open ocean.

N95-052 TITLE: Combat System Interface Simulation/Stimulation

OBJECTIVE: The objective of this topic is to develop innovative techniques for simulating/stimulating the signals and controls at the interfaces to a combat system.

DESCRIPTION: Combat systems interface to many sensors, users and other subsystems in an operational environment. In a submarine combat system, these include acoustic and non-acoustic sensors, navigation systems, communications systems, weapon systems, and combat system operators. During development and testing of the combat system, and during operator training, it is often impractical to have the entire interfacing environment available for interface stimulation and response. The offeror should propose innovative techniques for simulating the combat system interfaces and the responses that are expected during all states and phases of operation.

PHASE I: Demonstrate concept feasibility by developing a simulation architecture that will provide combat system interface stimulation and realistic responses without the need for the actual sensors and associated subsystems.

PHASE II: Demonstrate feasibility of the proposed conceptual architecture by developing a prototype combat system simulation/stimulation facility that provides realistic stimulation and response for a selected subset of the combat system interfaces.

PHASE III: Produce a complete combat system interface simulation/stimulation facility that can be used to provide realistic inputs and responses for use during system development, integration, test, and operator training.

COMMERCIAL POTENTIAL: This technology can be used for interface simulation and stimulation in large systems, as might be found in a ship or aircraft control system.

N95-053 TITLE: Submarine Portable Launch System

OBJECTIVE: The objective of this topic is to develop a small and portable submarine launch system from Commercial Off the Shelf (COTS) components system for use with weapons and other vehicles launched through submarine torpedo tubes.

DESCRIPTION: Currently SSN platforms and combat control systems are required to support a variety of missions and on-going weapon development/evaluation activities. The uniqueness of these multi-mission submarine warfare systems requires that all platforms, support all weapons/mines/vehicles at all times may be unrealistic. A portable launch system that implements a COTS based "Open System Architecture (OSA)" will provide a low cost ability to tailor the launch panel for specific applications in submarine ASW, Surveillance and other missions. This approach can alleviate the time and costs of CCS integration and provide the flexibility necessary to expedite submarine participation in new mission areas or evaluation of new weapons/vehicles. Submarine deployment of mines is a very good example of how this system can be applied.

PHASE I: Develop a generic concept through analysis of submarine mission areas where torpedo tube launched weapons/vehicles are appropriate for a stand alone portable launch system and develop a generic design concept which defines the system functional requirements and proposed COTS implementation for the portable launch system.

PHASE II: Develop Advanced Development Model to demonstrate concept/design.

PHASE III: Engineering Development or Production, if appropriate

COMMERCIAL POTENTIAL: Use of an Open COTS based design will provide the commercial sector with miniaturized analog to digital open system interfaces and multi-dimensional human system interfaces for remote operations are have potentially applicable to commercial industry in undersea exploration or robotics.

N95-054 TITLE: Submarine Low Cost Littoral Water Sonar Passive Localization System

OBJECTIVE: The objective of this topic is to develop a small, low cost, High Frequency Towed Array (HFTA) sonar system to be utilized for passive localization applicable to shallow water (littoral) areas.

DESCRIPTION: The current tactical towed array sonar systems developed by the Navy were designed to meet the anticipated threat expected to be encountered in open ocean operational areas. As a result, the frequency band covered was relatively low in response to the long range propagation characteristics of the ocean and the dominant acoustic energy emanating from the targets historically seen in these environments. A HFTA provides the potential for substantial improvement in detection capability in higher frequency bands, through isolation from hull generated noise mechanisms and provide equivalent classification capabilities as existing towed array systems in shallow waters - further, the spatial separation of the towed array from the hull array also provides a cost effective capability for passive localization when used in conjunction with the hull mounted array systems. Additionally, the HFTA coverage of the active sonar band will provide a separate bi-static or multi-static receiver for active sonar operations.

PHASE I: Analyze littoral water mission area where use of this type of sensor system would be appropriate. Develop a generic design concept which defines the system functional requirements and models the system for ability to transmit the large bandwidth of required data from the array to the submarine.

PHASE II: Develop Advanced Development Model to demonstrate concept/design.

PHASE III: Engineering Development or Production, if appropriate.

COMMERCIAL POTENTIAL: The technology is applicable to locating objects on the ocean bottom.

N95-055 TITLE: Development of Adaptive Filtering System to Eliminate CW Interference in Submarine IFM-based Electronic Support Measure (ESM) Systems.

OBJECTIVE: The objective of this topic is to develop a practical adaptive filtering system to replace notch filters in IFM systems.

DESCRIPTION: CW signals can interfere with the performance of ESM systems using IFM-type receivers; in some environments, CW signals can capture the receiver and preclude intercept of pulsed signals. Use of even a few tunable notch filters to exclude CW signals is cumbersome, resulting in signal power, space and cost penalties. Adaptive filtering techniques using advanced correlation devices such as SAWs for automatic exclusion of multiple CW signals in a system would be much simpler than present notch filters.

PHASE I: Design an adaptive filtering system to eliminate CW signals in IFM-based submarine ESM systems. Prepare Phase II Program Plan.

PHASE II: Develop a breadboard adaptive filtering system to replace present notch filters. Integrate with submarine ESM system and demonstrate performance in CW-exclusion in simulated signal environment known to degrade intercept performance.

PHASE III: The adaptive CW filtering system will be transitioned to deployed and future submarine ESM systems, providing superior intercept performance in the presence of interfering CW signals.

COMMERCIAL POTENTIAL: Intercept systems capable of performance in the presence of CW signals will have application to law enforcement systems used in activities such as drug interdiction.

N95-056 TITLE: Low Light Level Color Imaging with Image Processing

OBJECTIVE: The objective of this topic is to improve the capabilities of low-light level color imaging using either special image intensification techniques with application specific image processing algorithms, and etc.

DESCRIPTION: Color cameras have shown dramatic improvements in image quality, resolution, and dynamic range. However, very little improvement has been made in the area of image intensification. Under moderate to low light level conditions, these cameras generally perform very poorly. This poor performance has greatly limited the use of color cameras in system that operate in dusk/dawn environments. Because of the obvious advantages of color over monochrome (i.e. realism, better object recognition, submarine navigation, intelligence operation, and etc.), system's with low-light level requirements

could be dramatically improved if a color camera could be used in place of the existing monochrome (visible or FLIR) camera. This imagery could then be further improved if real-time application-specific image processing algorithms could be used to reconstruct the imagery and provide good color rendition from the poor raw imagery.

PHASE I: The contractor must develop an image processing system that will provide good color rendition from imagery obtained from intensified and non-intensified color cameras, i.e., from imagery where the light levels vary from 1000 lux to 1E-4 lux. As a minimum, the image processing system should correct the imagery such that one could be able to distinguish common shipboard (military and commercial) lights; i.e., red, white, green, and yellow, given typical commercial (source) luminosities taken at appropriate ranges.

PHASE II: Methodologies used to design and develop this system should include but not be limited by performance trade-off analyses of adaptive image painting and/or image contrast/color stretching of intensified and non-intensified color CCDs, or Silicon Injected Target sensors. Other more exotic designs are also encouraged. Using the chosen design, the contractor will manufacture three systems. All three systems will be provided to the government for further T&E. The contractor will provide monthly technical progress reports and a final comprehensive technical report of Phase II efforts.

COMMERCIAL POTENTIAL: The largest commercial application for this technology would be the camcorder market. The best low-light capability of today's commercial camcorders is about 1 LUX. This still results in snowy video under some typical video recording conditions. In addition, filming in some dusk/dawn conditions and at night is not possible. Improvements in low-light capability would greatly enhance the quality and usefulness of these commercial products.

N95-057 TITLE: Innovative Passive Electromagnetic Sensors for Submarines

OBJECTIVE: The objective of this topic is to develop new passive sensors for detection and tracking of aircraft contacts by submarines which utilize existing mast and antenna configurations.

DESCRIPTION: New submarine missions are being developed which will require submarine commanders to operate in littoral waters. These missions require the submarine to monitor the airspace in the operational areas. Many aircraft will be non-emitting and will remain undetected by conventional means such as ESM and IR sensors. New sensors are required that allow a real time picture of the airspace to be maintained passively. These new sensors must be able to use existing submarine antennae for signal reception. It is envisioned a Commercial Off The Shelf (COTS) based system will be able to provide radar-like presentation of the detected and tracked aircraft.

PHASE I: Explore new sensor technologies that provide the submarine with a passive aircraft tracking capability.

PHASE II: Build prototype systems for laboratory and at-sea testing.

PHASE III: Transition prototype test products to production baseline.

COMMERCIAL POTENTIAL: New sensors would be able to provide a backup capability to existing air traffic control systems at major airports in the event of their failure. Many small airports do not have radar systems due to the costs involved. These passive sensor systems are envisioned to be low cost and do not require transmitters, allowing many smaller airports to be able to monitor its' air traffic and increasing safety.

The Program Executive Office for Undersea Warfare PEO (USW)) is responsible for managing the acquisition of ASW systems, subsystems, and hardware and software components. Responding to the evolving needs of both the surface and submarine fleets in an era of changing threats and requirements, PEO(USW) works to ensure the maximum tactical advantage is available to the fleet to combat the undersea threat. Tactical areas of interest include: target surveillance; Detection, Classification, and Localization (DCL); data processing and display; weapon control and related computer subsystems; weapons; countermeasures; launchers; unmanned Undersea Vehicles (UUVs); handling and stowage equipment; related communication, command and control; support and training equipment. The PEO(USW) manages the following programs: Lightweight Torpedoes (MK 46 and Mk 50), Heavyweight Torpedoes (Mk 48 and Mk 48 ADCAP); Advanced Torpedo Warhead; Surface Ship ASW Combat System (AN/SQQ-89); Unmanned Undersea Vehicle and Targets; Torpedo defense and countermeasures (Surface Ship and Submarine); Joint US/UK Surface Ship Torpedo Defense; Vertical Launch ASROC; Navy Signal Processors (AN/UYS-1 and UYS-2); Undersea Warfare Advanced Systems and Technology Programs.

N95-058 TITLE: Develop an Active Advanced Signal Processing Techniques for Active Sonar Contact Classification

OBJECTIVE: Develop active sonar classification techniques based upon adaptive processing of contact data processed in affordable signal processors.

DESCRIPTION: Innovative solutions using graphical command/control interfaces and state of the art techniques coupled with advanced processing technology are sought which are cost effective and compatible with on board equipment. Sonar performance in shallow water has been demonstrated to have a higher false alarm rate than deep water environments. Signal processing techniques capable of sorting target from non-target are required to successfully operate in these areas. Improvements in shipboard signal processing capabilities using advanced processing technology will make it possible to realize the implementation of computationally intensive processing algorithm which have not been possible in the past. Active classification research efforts to date have identified a number of promising processing techniques to extract the maximum information possible out of an active waveform. We desire to improve classification reliability while reducing the threshold between detection and classification.

Specific examples of advanced processing techniques include the use of time frequency/time scale analysis, programming by pictures, and the use of higher order moments to improve classification. The proposed solution will examine a number of advanced processing techniques which have previously been promising but which have not been affordable because they were computational intensive. Alternatives for time frequency, graph object, and time scale analysis all of which focus on improving their solution of parameters required to correctly classify a target are needed. Higher order moments associated with real world, non-gauss active returns may also improve classification. Fusion of clues extracted by various techniques cited above or others which result from this effort will likely be required. An important aspect of this effort is that algorithms be implemented with ongoing commercial processor advances to insure adaptability and affordability.

PHASE I: Show feasibility of the concept.

PHASE II: Demonstrate the product.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Expected commercialization include harbor surveillance, navigational and fishing applications, scientific exploration, development of application software.

N95-059 TITLE: Develop Adaptive Neural Network Signal Processing

OBJECTIVE: Develop and demonstrate situationally adaptive neural network sonar classification techniques for real time classification, in a high clutter environment of active sonar contacts.

DESCRIPTION: Innovative cost effective solutions are sought that use situationally adaptive neural networks for real time classification that are compatible with existing equipment and are designed to make complete use of Doppler, velocity dynamics, echo shape echo shape moments and other significant target echo features.

A. Rapid detection, classification, and localization (DCL) of targets in shallow water environments is needed to support Navy warfare missions. Due to the time-varying environments and the difficulties associated with obtaining accurate measurements in these environments, it is necessary to consider robust adaptive DCL algorithms. These features seek to insure that accurate measurements, when available, are used to best advantage, and inaccurate measurements are recognized quickly and appropriately discounted before they adversely affect the DCL estimates. Research efforts to date have concentrated on the use of Probabilistic Neural Networks (PNNs) and Back Propagation (BP) neural networks for the classification of signals in spectrograms and classification using active sonar returns.

B. A key consideration is the ability to implement the neural network processing algorithms in NDI/COTS based processors using reasonable computational resources. Offerors shall propose developing a signal processor concept design. Successful design would transition to an operational system upgrade.

PHASE I: Show feasibility of the concept.

PHASE II: Demonstrate the product.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Expected commercialization includes harbor surveillance, fishing applications and scientific exploration.

N95-060 TITLE: Develop Advanced Directed Energy/Blast Warheads for Torpedo Applications

OBJECTIVE: Develop a lightweight torpedo warhead design to provide both ASW (Anti-submarine warfare) and ASUW (Anti-surface warfare) capability with enhanced blast explosive and sub caliber shaped charge liner is desired.

DESCRIPTION: Current lightweight torpedoes are extremely limited in the size and weight available for the warhead and major compromises are made in the torpedo design to ensure a single capability is maximized for the specific weapon. The capability to incorporate advanced blast explosives and an advanced shaped charge linear will be developed. The new system shall be capable of specified performance in certain classified scenarios. This warhead can ultimately be used in the COMMON TORPEDO of the next century. The design of this warhead should have specific cost goals and thresholds in production. The design will ensure that all safety and reliability criteria for ordnance is met and performance in specific scenarios is achieved. Additionally a complete and EPA approved disposal process will be required for the warhead system. Innovative solutions are sought which after examining current technology for packaging, power, and performance provide a design for production implementation.

PHASE I: Show feasibility of the concept.

PHASE II: Demonstrate the product.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: This product would be appreciated for advanced explosive for mining and seismic studies.

N95-061 TITLE: Develop Active/Passive Data Fusion Operator Associate

OBJECTIVE: The objective of this topic is to develop a situational assessment tool featuring the fusion of active and passive submarine sensor detection results.

DESCRIPTION: Submarine sonar systems lack effectiveness in shallow water deployments. The dense obstacle environments typical in shallow water impedes the effectiveness of these sonar systems. The association, correlation, and combination of data from multiple sources to achieve a complete assessment of threats in a timely manner is of the utmost importance in this environment. Data fusion enhancements offer the potential for improving the performance of sonar sensors.

This effort will focus on the design, development, and demonstration of a submarine sonar operator aid to assist in the fusion of all acoustic processed information. Offloading the combat control operator of tasks that lend themselves to automation and developing a clear method of presentation are key to this effort. The requirements for specific automation algorithms and operator aids will be defined and a conceptual design developed. Fusion of all simultaneous operating active sonar data (medium and high frequency) will be investigated as well as using the passive sensor data from any array along with any other sources of opportunity. Blending of current MMI designs and computer aided/automated techniques with capabilities supported by ongoing workstation advances will be key concerns of this effort. The requirements for specific automation algorithms and operator aids will be defined and a conceptual design developed. Fusion of all simultaneous operating active sonar data (medium and high frequency) will be investigated as well as using the passive sonar data from any array along with any other sources of opportunity. Blending of current MMT designs and computer aided/automated techniques with capabilities supported by ongoing workstation advances will be key concerns of this effort.

PHASE I: Show feasibility of the concept.

PHASE II: Demonstrate the product.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Products from this development effort have potential application for harbor surveillance, navigation aids and scientific exploration.

N95-062 TITLE: Exploration of Sources of Opportunity for Submarine Sonar Systems

OBJECTIVE: The objective of this topic is to develop a combination of realtime signal processing, tactics and existing sensors that can provide a tactical advantage to a submarine against an unsuspecting target.

DESCRIPTION: By combining signal processing, tactics and existing sensors increased tactical capability for submarines in littoral warfare environments can be achieved. In time critical battle management situations are deployment of an active sonar

source has inherit advantages due to its speed of delivery. Other fixed and mobile sources of opportunity already positioned may provide a tactical advantage to submarines against unsuspecting targets. Using planned improvements in shipboard signal processing capabilities combine with recent advances in air deployed active sources (i.e. ; EER and ADLFP), and developing tactics which allow either a submarine or surface vessel to exploit air deployed sources while remaining covert, this potential can be realized.

We intend to develop a wavefront curvature technique to perform source localization on the direct blast. If the transmit waveform is not known, the direct blast will be used to develop a replica of the transmit waveform. Matched filter processing will be use to capture replica as a substitute for the transmit waveform. The directivity index shipboard sensors will have an advantage over air deployed receivers providing improved performance for target persecution. Real time, signal processing which adapts to sources of opportunity will be designed and developed. Tactics to arrive at processing requirements will be examined.

PHASE I: Show feasibility of the concept.
PHASE II: Demonstrate the product.
PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Expected commercialization includes harbor surveillance, fishing applications and scientific exploration.

N95-063 TITLE: Develop the Dynamic Behavior of a Unmanned Undersea Vehicle (UUV) Surf Zone Vehicle Control

OBJECTIVE: Investigate dynamic behavior of a UUV operating in a Very Shallow Water (VSW) environment in support of amphibious operations and develop suitable control systems.

DESCRIPTION: This topic has direct application to all UUV's which operate in coastal areas. Hydrodynamic models are required to support the development of UUV control systems. Accurate and robust hydrodynamic models are essential for performance prediction of UUV control behavior within the surf zone. The final objective is to determine the optimum vehicle size, range and configuration for employment in the surf zone. Innovative solutions are sought and offers should propose various control system concepts based on results from the hydrodynamic computer models, develop appropriate physical models, and conduct testing to verify designs.

PHASE I: Show feasibility of the concept.
PHASE II: Demonstrate the product.
PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Application of this product would provide commercial ROV/UUV's a better ability to bottom map, survey (pipelines, cables, piers, bridges), and perform work (repair, salvage) in high surf zone coastal waters.

The next four topics apply to the Aegis Class of ships. The Aegis Program is responsible for the deign, development, engineering, acquisition, production, and life cycle support of AEGIS cruisers and destroyers including their combat systems. The AEGIS Program is committed to delivering and maintaining reliable, capable, affordable ships to the operational Navy. Since the AEGIS Program has a broad shipbuilding responsibility, it also has a corresponding interest in innovative high payoff technologies to meet its commitments. Technologies contributing to the design and maintenance of capable and affordable anti-air warfare systems are of current interest. Proposals are sought in the following general areas that are particularly applicable to the AEGIS Program:

N95-064 TITLE: Radar Simulation

OBJECTIVE: The objective of this topic is to develop a flexible radar simulation for design, analysis and test support of military and civil systems.

DESCRIPTION: The simulation should be block oriented permitting various degrees of subsystem abstraction. Abstraction levels may run from the signal processor bit level to closed form mathematical expressions. Particular attention must be paid to radar environmental factors such as propagation, clutter, and target models. The simulation should run under MS DOS.

PHASE I: Show feasibility of concept. Survey literature and existing simulation technology, and determine if elements of existing technology can be used for a simulation structure and construction of a limited simulation.

PHASE II: Development and evaluation of the full scale simulation with accompanying documentation. The model shall be available for user evaluation and subsequent update prior to delivery.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Commercial potential exists for radar design, test, and analysis tool development.

N95-065 TITLE: Develop Concepts for Delivering Logistic Information

OBJECTIVE: The objective of this topic is to develop an effective, innovative system for delivering digital logistic information to ships. This digital information mimics published maintenance manuals, including both text and images. Dual-use application to any commercial off-site activity requiring extensive logistics information.

DESCRIPTION: Shipboard access to maintenance information is presently restrictive; but maintenance personnel require a single-source response to their inquiry for maintenance information and repair parts; and require each response provide current information in correct format and context. The Navy CALS (Computer Aided Acquisition and Logistics Support) program will replace the present paper logistic documents with digital replications. This requires new system definition and assessment of the impact upon logistic procedures and products, and a transition strategy.

PHASE I: Develop the concepts, define the system, and identify impacts on current procedures and products, and develop a transition and implementation strategy for digital logistic information.

PHASE II: Implement the new system and concepts on a pilot project for selected shipboard systems.

PHASE III: Produce and market the product.

COMMERCIAL POTENTIAL: Any commercial off-site activity requiring immediate access to large amount of technical and logistic information can apply this new concepts (Construction crews, off-shore oil rigs, maintenance/repair work crews).

N95-066 TITLE: Semi-Portable Antenna Near-Field Scanner

OBJECTIVE: Develop the concepts and design a low-cost, semi-portable antenna near-field scanner system capable of performing diagnostics and antenna measurements and allowing rapid installation and alignment at various locations to support antenna development or overhaul operations..

DESCRIPTION: In order to rapidly diagnose various antenna performance parameters, a low cost semi-portable near-field scanner is required.

PHASE I: Develop and evaluate one or more designs for the proposed system. The concept design(s) will address, at a minimum, major technical hurdles and their implementation; performance targets including speed and accuracy, and measurement capabilities. A partial implementation of one or more candidate designs will be presented.

PHASE II: Demonstrate the Phase I with a complete prototype system for one of the systems developed and reviewed under Phase I. The system design will be documented for future production, for future installations and use, and for future system enhancements.

PHASE III: Upon successful completion of Phase II, systems would be of immediate benefit to all Navy, DOD or other government installations doing antenna work by providing a quick and effective method of performing antenna measurements and diagnostics.

COMMERCIAL POTENTIAL: The scanner is expected to have immediate benefits for any commercial, university, government or other laboratory which performs measurements of antenna parameters or antenna development work.

N95-067 TITLE: Develop Robust Estimation for Target Tracking

OBJECTIVE: Develop a robust estimation techniques/algorithm and verify performance via simulation, that enhances/improves radar tracking filter performance when the system model varies significantly from the design model.

DESCRIPTION: Robust modern control theory has been a topic of research that has received much attention in the past decade. More recently, several advances have been made in robust estimation theory. In cases where a precise model of the system is difficult to obtain or where the disturbances have unknown means and dynamic variations, the robust estimator should demonstrate improved estimation performance. The robust estimation techniques should address the importance/benefits of using weighing filters to model desired tracking performance at the frequencies of interest as well as identify criteria for their selection and design.

PHASE I: Develop technique/algorithm and demonstrate via simulation improved tracking of highly maneuverable targets in a noisy environment.

PHASE II: Develop an optimal filter design and develop real time tracking filter. Demonstrate using recorded radar track data.

PHASE III: Implement real time filter design in a radar tracker. Demonstrate performance against real targets.

COMMERCIAL POTENTIAL: Aircraft multiple targets tracking and control processes. (Air traffic control, airspace monitoring, etc.).

AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Materiel Command Deputy Chief of Staff for Science & Technology. The Air Force SBIR Program Executive is R. Jill Dickman. Do NOT submit SBIR proposals to the AF SBIR Program Executive under any circumstances. Inquiries of a general nature or problems that require the attention of the Air Force Headquarters should be directed to this address:

Department of The Air Force
HQ/AFMC/STXB (AF SBIR Program Executive)
4375 Chidlaw Rd
Suite 6
Wright-Patterson AFB OH 45433-5006

No additional technical information (this includes specifications, recommended approaches, further refinement, the limiting of topic areas, and the like) can or will be made available by Air Force personnel during the solicitation period. References are listed for most topics. The only other source for technical information is the Defense Technical Information Center (DTIC). Information is key to successful proposal preparation and research; however, locating pertinent information is often difficult. For this reason the DoD SBIR Program is working on better ways to serve the small business community with information support. Please refer to section 7.1 in this solicitation for further information on DTIC.

The maximum amount of SBIR funding used for any Air Force Phase I award shall be $80,000.

PROPOSAL SUBMISSION INSTRUCTIONS

For each Phase I proposal, send one original (with red appendices A and B) and three (3) copies to the office designated below. Also, send an additional set of red appendices A and B, which are not stapled or mutilated in any way. Be advised that any overnight delivery may not reach the appropriate desk within one day.

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS (Name and number for mailing proposals and for administrative questions)	CONTRACTING AUTHORITY (For contractual questions only)
AF95-001 thru AF95-006	Arnold Engineering Development Center AEDC/DOTP Arnold AFB TN 37389 (Kevin T. Zysk, (615) 454-6507)	Dowe Jones (615) 454-4423
AF95-007 thru AF95-011	Air Force Office of Scientific Research AFOSR/XPP (Chris Hughes) 110 Duncan Avenue, Suite B115 Bolling AFB DC 20332-0001 (Chris Hughes, (202) 767-5015)	Ernest Zinzer (202) 767-4990
AF95-012 thru AF95-037	Armstrong Laboratory AL/XPTT 2509 Kennedy Circle Brooks AFB TX 78235-5000 (Belva Williams, (210) 536-2103)	Sharon Shen (512) 536-6393
AF95-038 thru AF95-070	Rome Laboratory RL/XPX 26 Electronic Parkway Griffis AFB NY 13441-4514 (Robert Falk, (315) 330-2912)	Mary Lovett (315) 330-2804
AF95-071 thru AF95-088	Phillips Laboratory - Space & Missile Technology Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Room 239 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Roger Shinnick (505) 846-2664
AF95-089 thru AF95-092	Phillips Lab - Advanced Weapons & Survivability Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 239 3650 Aberdeen Ave. S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Rudy Fourzan (505) 846-6877

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
AF95-093 thru AF95-097	Phillips Laboratory - Rocket Propulsion Directorate OL-AC Phillips Laboratory/TO (Attn: Ms Sandra Borowiak) 135 East Antares Road Edwards AFB CA 93524-7440 (Ms Sandra Borowiak, (805) 275-5617)	Ms. Donna James (805) 277-2716
AF95-098 thru AF95-105	Phillips Laboratory - Geophysics Directorate OL-AA Phillips Laboratory/XPG 29 Randolph Rd, Bldg 1107 Rm 240 Hanscom AFB MA 01731-3010 (Noreen Dimond, (617) 377-3608)	Mr. John Flaherty (617) 377-2529
AF95-106 thru AF95-115	Phillips Laboratory - Lasers & Imaging Directorate PL/XPI (Attn: Bob Hancock) Bldg 497 Rm 239 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Mr. Gerry Meyer (505) 846-4422
AF95-116 thru AF95-117	Phillips Laboratory - Operations And Plans & Programs Directorates PL/XPI (Attn: Bob Hancock) Bldg 497 Room 239 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Maj Ron Unruh (505) 846-1346
AF95-118 thru AF95-119	Phillips Laboratory - Space Experiments Directorate PL/XPI (Bob Hancock) Bldg 497 Rm 239 3650 Aberdeen Ave S.E. Kirtland AFB, NM 87117-5776 (Bob Hancock, (505) 846-4418)	Ms. Tammy Johnson (505) 846-6923
AF95-120 thru AF95-134	WL/AAOP Bldg 22 2690 C St, Ste 3 Wright-Patterson OH 45433-7410 (Sharon Gibbons, (513) 255-5285)	Terry Rogers or Bruce Miller (513) 255-5830
AF95-135 thru AF95-143	WL/ELA Bldg 620 2241 Avionics Circle Ste 29 Wright-Patterson, OH 45433-7331 (Howard Romaker, (513) 255-6723)	Terry Rogers or Bruce Miller (513) 255-5830

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS	CONTRACTING AUTHORITY
AF95-144 thru AF95-157	Wright Laboratory Flight Dynamics Directorate WL/FIOP BLDG 45 2130 Eighth St, Ste 1 Wright-Patterson, OH 45433-7542 (Madie Tillman, (513) 255-5066)	Terry Rogers or Bruce Miller (513) 255-5830
AF95-158 thru AF95-175	WL/MLIP BLDG 653 2977 P St, Ste 13 Wright-Patterson, OH 45433-6523 (Sandy Warren, (513) 255-7175)	Terry Rogers or Bruce Miller (513) 255-5830
AF95-176 thru AF95-192	WL/POMX Bldg 18 1950 Fifth St, Room 105A Wright-Patterson OH 45433-7251 (Betty Siferd, (513) 255-2131)	Terry Rogers or Bruce Miller (513) 255-5830
AF95-193 thru AF95-197	WL/MTX BLDG 653 2977 P St, Ste 6 Wright-Patterson, OH 45433-7739 (Marvin Gale, (513) 255-4623)	Terry Rogers or Bruce Miller (513) 255-5830
AF95-198 thru AF95-204	ASC/XRP, Bldg 56 2100 Third St Ste 2 Wright-Patterson OH 45433-7016 (Fred Strawn, (513) 255-6673)	Arnette Long (513) 255-6134
AF95-205 thru AF95-206	Wright Laboratory - National Aerospace Plane ASD/NAF Wright-Patterson OH 45433-6523 (Dr. Kervyn Mach, (513) 255-1858)	Cathy Doyle (513) 255-9637
AF95-207 thru AF95-227	Armament Directorate WL/MNPB 101 West Eglin Blvd, Suite 143 Eglin AFB, FL 32542 (Richard Bixby, (904) 882-8591)	Lyle Crews, Jr (904) 882-4284
AF95-228 thru AF95-249	ASC/SMEM, Bldg 22 2690 C St, Ste 5 Wright-Patterson AFB, OH 45433-7412 (Jerry Gazzell, (513) 255-3442)	

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	WRIGHT LABORATORY - MANUFACTURING TECHNOLOGY DIRECTORATE, WRIGHT-PATTERSON AFB OH
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WRIGHT LABORATORY - NATIONAL AEROSPACE PLANE JOINT OFFICE, WRIGHT-PATTERSON AFB OH

AF95-205	Fracture Toughness Analysis of Metastable Beta Titanium Alloys
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WRIGHT LABORATORY - ARMAMENT DIRECTORATE, EGLIN AFB FL

AF95-207	Armament Research
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AF95-209	Detection of Buried Structures and Materials
AF95-210	Optical Materials for Spatial Light Modulators
AF95-211	Pulsed Fiber Optic Laser
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AF95-213	Environmental Effects of Tungsten and Tantalum Alloys
AF95-214	High Speed Charge Coupled Device (CCD) Signal Processing and Data Acquisition Chip Set
AF95-215	Optimal Design of Methodology for Complex, Nonlinear, Multidimensional, Noninterdependent, Multivariable System Using Nonlinear Programming
AF95-216	High Intensity Illumination System (HIIS)
AF95-217	Non-volatile Shock Recorder
AF95-218	Ultralow Impedance High Voltage Connector
AF95-219	Two-Dimensional Avalanche Photodiode Arrays
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AF95-221	An Improved Method of Determining the Equations of State of Concrete and Geological Materials
AF95-222	High Power Diode Driver Development
AF95-223	Terradynamic Performance Improvements
AF95-224	Environmental Fate and Remediation of High Explosive Residue
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TECHNOLOGY TRANSITION OFFICE, WRIGHT-PATTERSON AFB OH

AF95-228	Linear Motor Actuator

AF95-229	Jet Engine Fuel Tubes and Manifolds Clearing and Cleaning
AF95-230	High-Dynamic, Multi-Configurable, Flight-Reference System
AF95-231	Hypersonic-Vehicle Thermal Protection for High-Temperature Oxidizing Environments
AF95-232	Catalyst for Flooded Type Lead-Acid Batteries
AF95-233	Superconducting Magnetic Energy Storage (SMES) System with Adaptable Voltage Level Output
AF95-234	Micro-Superconducting Magnetic Energy Storage (SMES) System Scale-up for Substation Applications
AF95-235	Infrared Focal Plane Array Tester
AF95-236	Composite Shelter Manufacturing
AF95-237	High Speed Detector Technology for Fourier Transform Infrared (FTIR) Applications
AF95-238	Infrared Continuous Wave Lasers
AF95-239	Synthesis Aperture Radar (SAR) Hardware-In-The-Loop (HITL) Simulation
AF95-240	Quick Look Capability for Warhead Arena Testing
AF95-241	Munitions Warfare Systems Test and Evaluation Technologies
AF95-242	Anechoic Chamber Computer Software Model Simulation
AF95-243	Large-Volume, High-Speed, Data-Management Technology
AF95-244	Innovative Infrared (IR) Scene Generation Using Defense Mapping Agency (DMA) Database
AF95-245	Optical Coupler Between Infrared (IR) Scene Emitter and Installed Sensors
AF95-246	Non-Electromagnetic Interfering (EMI) Signal Injection Technology
AF95-247	Radar-Transparent Self-Stabilizing Support for Infrared Sensor Stimulator Head
AF95-248	Green Masking for Microcircuit Lithography
AF95-249	Dual-Use Neutron Beam

SUBJECT/WORD INDEX TO THE AIR FORCE SBIR SOLICITATION

DEPARTMENT OF THE AIR FORCE
SBIR 95.1 TOPIC DESCRIPTIONS

AF95-001 TITLE: Remotely Deployable Devices for Detection of Oil Sheen

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a remotely deployable sensor system to sense hydrocarbons present in waste water.

DESCRIPTION: Test facilities at AEDC use vast quantities of water for cooling. Altitude test processes can periodically release into the local waste-water systems small but potentially environmentally damaging amounts of petroleum fuels and other hydrocarbon fluids. Localized sensing and classification of the effluent contaminants, to meet EPA standards, requires adherence to graviometric methods (EPA Procedure 600/4-79-020.413.1) that are based on grab samples. Existing monitoring systems can't be manned continuously nor necessarily near the point of release. An inexpensive remotely-deployable sensor system that reports back to an operations center using phone lines, a computer network, or dedicated lines is required. The successful development of such a method, even if quantitative, would not necessarily replace the EPA standard procedure but rather would serve as an alarm. Optical methods should be considered, as visual inspection successfully relies on the presence of an oil sheen.

PHASE I: The Phase I objective is to demonstrate the technologies required to complete such a system, provide an overall system plan and to demonstrate the detection of commonly utilized hydrocarbons.

PHASE II: The Phase II objective is to build a prototype of a marketable and reliable remote sensor system for the detection of hydrocarbon waste in water for AEDC applications.

COMMERCIAL POTENTIAL: Municipalities charged with the maintenance of water quality, chemical processing plants, refineries, aviation facilities, mass fuel storage facilities, and manufacturing facilities would be users of this device.

REFERENCES:
1) Standard Methods for the Examination of Water and Wastewater, Edited by Arnold E. Greenberg, Lenore S. Clesceri, and Andrew D. Eaton, 18th Edition of 1992

2) EPA Methods For Chemical Analysis of Water and Waste, EPA 600/4-79-020

AF95-002 TITLE: Measurement of Water-Vapor/Ice Content of Large Industrial Air Flows

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Accurate, Reliable Measurement of Water Vapor and/or Ice Content of Large Industrial Air Flows

DESCRIPTION: Where particulates and other condensable vapors are present, as is often the case, means do not exist to accurately, reliably, and rapidly measure the water vapor and/or ice content of industrial air flows, especially flows in ducts from 1 foot to 15 feet in diameter. By rapid measurement is meant measurement accomplished in real time with less than one to a few seconds delay, measurements being repeated continually at the same time interval. Uncertainty requirements and flow conditions may vary with the industrial situation and the uses of the measurement, but, to be funded, at least one of the representative sets of requirements and conditions below must be met by the measurement system. All flow velocities are less than Mach 0.3. The measurement device may intrude into the duct so long as the blockage is low; less than 5% is required, below 1% is desired. Measurement may be made at a single effective location along the centerline of the flow. Simultaneous measurements at additional effective location are preferred at area-weighted positions in a single flow cross section. The device must be self-calibrating once installed. Remote operation without personnel intervention into the duct is required for a minimum of 24 hours; 30 days is preferred. The environment outside the duct is industrial, inside a building, and at atmospheric pressure with temperature ranging from outdoor ambient to that of the flow. With no condensed water present, the particulate content of the flows may be modeled by room air, but with different materials in the particles. Duct air density at the measurement site

will be available. Using one or more of the following letters, the respondent must indicate the uncertainty/flow-condition combination(s) that the proposal addresses:

a. Flow containing from 18 to 140 grains of gaseous water per lbm of air, with gaseous water content measured to plus or minus 7 grains/lbm. Flow temperatures are from -40 F to 450 F at flow pressures from 2 to 40 psia (requirement) or 2 to 125 psia (desired). Measurements are not required in that portion of the combination of these parameter ranges where condensed water vapor is present, but an indicator of the presence of water-vapor condensation is required.

b. Flows containing from 1 to 50 grains of gaseous water per lbm of air, with gaseous water content measured to plus or minus 4 grains/lbm. Flow conditions and requirements regarding condensed water vapor are as in (a).

c. Flows containing from 0.5 to 20 grains of water per lbm of air, with only the water content in supercooled droplets and ice particles measured. Water content is to be measured (1) in particles and droplets with maximum dimension above D1 and (2) in particles and droplets with maximum dimension between D1 and D2. D1 is to be 5 microns and D2 is to be 0.5 microns both within a factor of 2 uncertainty. Flow temperatures are from -40 F to 32 F and flow pressures from 2 to 40 psia.

PHASE I: The Phase I objective is to demonstrate the technologies required to complete such a system and provide an overall system plan.

PHASE II: The Phase II objective is to build a prototype of a marketable reliable measuring-device for measuring the water-vapor and or ice content of large industrial air flows.

COMMERCIAL POTENTIAL: This measuring device will provide the industrial process drying industry with a means to accurately control moisture content in process air. Within this grouping, paper products manufacturers, large scale food processors, drug manufacturers, ceramic component fabricators, and the textile industry will benefit from the commercial availability of this device.

REFERENCES:

1. Engine Test Facility "Fact Sheet," Office of Public Affairs, Arnold Engineering Development Center, Arnold AFB, TN 37389-5000 (615) 454-5586

2. Aeropropulsion Sytem Test Facility (ASTF) "Fact Sheet," Office of Public Affairs, Arnold Engineering Development Center, Arnold AFB, TN 37389-5000 (615) 454-5586

AF95-003 TITLE: <u>Sensitive Portable Gaseous Leak Locator</u>

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a sensitive, portable leak detector and locator for a suite of trenchant gases.

DESCRIPTION: A man-portable sensor system is required for the remote detection and location of small leaks of trenchant gases. Changeover from locating leaks of one gas in the suite of gases to locating leaks of another must be accomplished by a technician with easy equipment changes in little time. As an initial archetype, a portable system to detect and locate small leaks of ozone-depleting compounds from small to huge refrigeration facilities will be developed. For this archetype, gases, in order of priority, are Freon R-12, R-22, R-134a, and trichloroethylene. This system will be open-ended, that is, it cannot require the placement of additional material behind the leak for its detection. The system may make use of existing solid surfaces behind the leak so long as these surfaces do not have to be modified from their original state and so long as they may be at any distance. Minimum detection rates will be 5 lbm/year or less for each of the suite of gases. The gases to be detected will typically be at a temperature of less than 350 K. The system must be capable of being operated by instrument technicians not having knowledge of its theory of operation. The sensor system must be portable and easily carried by one person as that person moves over, around, and perhaps under typical tankage and piping seeking to detect and locate leaks. Under typical vented-building conditions, the system must detect a leak anywhere in the range of from 5 to 60 feet without operator intervention when the operator points the center of the field of view of the system anywhere within a minimum arc of 5 degrees about the direction of the leak. At the same time, the location of the leak must be evident to the operator to within plus or minus 5 degrees maximum (assuming the view of the leak is unobstructed). Once the leak is detected the operator must be able to easily put the system into a locate mode if a change of mode is necessary to meet the following locate-mode specifications. In the locate mode, under the same conditions, the above specifications apply except the range interval is 5 to 20 feet and the 5 degree value above is everywhere 0.5 degrees. At all times, the operator must be aware of the field of view covered by the system within the

operator's own field of view that must be a minimum of approximately ten times wider than the minimum system value in each mode. It is a requirement that the system operate to the above specifications over the range of normal interior lighting conditions, including sunlight illumination through windows. Operation outdoors under direct sunlight conditions and/or other weather conditions is desirable. The system must meet all ANSI eye-safety conditions and be safely operated in confined conditions.

PHASE I: The Phase I objective is to demonstrate the technologies required to build such a device and to provide an overall system plan.

PHASE II: The Phase II objective is to produce a prototype "Sensitive Portable Gaseous Leak Locator" that is reliable and marketable.

COMMERCIAL POTENTIAL: This device will benefit the commercial refrigeration industry by providing a means to detect small leaks in cooling equipment. In addition, this device will have applications in the consumer automotive and home air-conditioner repair industry, both major sources of ozone depleting chemical leaks.

REFERENCES:

1. Engine Test Facility "Fact Sheet," Office of Public Affairs, Arnold Engineering Development Center, Arnold AFB, TN 37389-5000 (615) 454-55862. Aeropropulsion System Test Facility (ASTF) "Fact Sheet," Office of Public Affairs, Arnold Engineering Development Center, Arnold AFB, TN 37389-5000(615) 454-5586

AF95-004 TITLE: Large Very Narrow IR Bandpass Filter Development

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop very narrow IR bandpass filters for reducing radiometric background during IR staring sensor testing.

DESCRIPTION: Low background laser testing of IR focal plane arrays (FPAs) under simulated space conditions cannot be accomplished without the use of very narrow (< 0.1% of center wavelength) bandpass filters. In AEDC's Scene Generation Test Capability (SGTC), there is a need for large (4 inch diameter, 90% clear aperture) filters that can accommodate the field of view (FOV) of a 512 X 512 staring FPA. Currently these are very difficult to fabricate with the necessary tolerances over the entire clear aperture of the filter. Laser bandpass filters are required at an operational wavelength of 5.43 microns (at 20 K) that have a center accuracy of 0.005 microns, a uniformity of plus or minus 0.004 microns, and a bandpass of 0.1%. The spectral shift due to a 12.5 degree incident angle must be less than 0.3%.

PHASE I: The objective of Phase I is to produce a design for a 4 inch narrow IR bandpass filter and conduct proof of concept tests demonstrating the design.

PHASE II: The objective of Phase II is to fabricate four prototype filters that are reliable and marketable. Filter specifications will be provided by AEDC in cooperation with the SBIR contractor.

COMMERCIAL POTENTIAL: These filters will be useful in the development and operational test and evaluation of focal plane arrays to be used by commercial light weight launch-systems and spacecraft. They will also be useful for commercial remote sensing satellite systems and other test facilites that utilize the CO gas laser.

REFERENCES:

1. Lowry, H.S., Elrod,P.D. and Layne, T.C., AEDC-TR-92-1, "AEDC's Transportable Direct Write Scene Generation Test Capability," Presented at Proceedings of the Fourth SDIO Scene Projection Workshop (SPW IV), AEDC, 4 Dec92,

2. Lowry, H.S., Doub, C.A., and Johnson, R.J., "Optimization of Laser Scan Lens System for Minimum Cross Talk," SPIE Vol. 1967 (1993)

AF95-005 TITLE: High-Speed Two-Axis Acousto Optic-Deflector

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop high speed IR two-axis acousto-optic deflectors for scene generation

DESCRIPTION: One path that the design of IR focal plane arrays (FPAs) for defense missions has taken to circumvent the operational upsets due to gamma ray events is to use a very small fill factor and a very fast integration time. The small fill factor decreases the probability of such events, and the fast integration time allows the use of several "subframes" to localize the upset event. AEDC's FPATC currently uses deflectors with time bandwidth products of 256 X 256 and above with access times of from 15 to 25 micro-seconds. These deflectors can accommodate currently proposed FPA designs by operating at 2 to 3 times the integration time of the FPA or by decreasing complexity in the projected scene. It is possible that higher speed two-axis acousto-optic deflectors capable of the required resolution can be constructed with newly developed materials. Acousto-optic deflectors are required that will be capable of projecting scenes to these FPAs. These deflectors must have a time bandwidth product on the order of 256 X 256 and an access time of less than 5 micro-seconds. The optical aperture must be large enough to produce a spot size commensurate with the pixel pitch of the FPA. The wavelength range of interest is from 1.0 to 12.0 microns.

PHASE I: The Phase I objective is to demonstrate a design for high-speed two-axis acousto optical deflectors that can provide for scene generation testing of focal plane arrays with high pixel count and short integration time.

PHASE II: The Phase II objective is to fabricate three prototype two-axis deflectors that are reliable, marketable, and suitable for AEDC's testing needs.

COMMERCIAL POTENTIAL: These deflectors will be useful in the development and operational test and evaluation of focal plane arrays to be used in military sensor systems. They will also be of similar use in testing commercial remote sensing satellite systems, as well as providing technology upgrades in the areas of optical processing, RF spectrum analysis, high frequency multi-wavelength laser stabilizers, and acousto-optical filter (AOTF) techniques.

REFERENCES:
1. Lowry, H.S, Doub, C.A., and Johnson, R.J., "Optimization of Laser Scan Lens Systems for Minimum Cross Talk," SPIE Vol. 1967 (1993)

AF95-006 TITLE: Miniature Transducers for High Acceleration Applications

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop miniaturized transducers for the high "g" environment of light gas gun models

DESCRIPTION: In order to improve the reliability of the hypervelocity Range G model design process, data on in-barrel and free-flight model loading and material response are required. Four "g hardened" miniature transducer types are required for these in-barrel and free-flight measurements: pressure transducers for model base pressure, roll sensors, accelerometers for axial and lateral loading, and strain gages for material response. These transducers will interface with an on-board sub-miniature telemetry/power-supply package provided by AEDC. The transducers should be designed to accommodate and measure axial accelerations to 120,000 g's, lateral accelerations to 30,000 g's, model base pressures to 60,000 psi, and roll rates to 200 rev/sec. Miniature transducers are also required for making in-flight model measurements for surface heat flux, surface temperature, and pressure at the stagnation point and wall. These transducers must withstand the launch loads previously mentioned. Stagnation point gages should measure pressures to 500 atm, temperature to 6000 R, and heat fluxes to 50,000 BTU/ft2-sec. Wall gages should measure pressure to 10 atm, temperature to 2500 R, and heat fluxes to 1500 BTU/ft2-sec. The dynamic response of all transducers should not be less than 100 KHz (10 micro-seconds to 90% of full scale). All transducers must be compatible with a 10-deg-half-angle spherically-blunted cone with a 3-in base diameter and have minimal affect on aerodynamic parameters. Surface condition measurement transducers should penetrate a cone wall thickness of 0.375 inches. Transducer size, including support electronics, should not exceed 0.02 cubic inches. AEDC electronics will require 0.25 cubic inches, including power supply (5 volts).

PHASE I: The Phase I objective is to demonstrate the technologies required to fabricate these miniature transducers and perform subscale tests.

PHASE II: The Phase II objective is to fabricate 10 transducers of each type for testing in AEDC' G Range models.

COMMERCIAL POTENTIAL: These transducers will be used in the evaluation of performance of artillery projectiles used by the military both in-barrel and free-flight test programs. This technology can be transferred to applications requiring on-board measurements in automobiles and non-military aircraft with critical size limitations. Also of value, is the application of these transducers in the new generation of small, lightweight space vehicles envisioned for the commercialization of space.

REFERENCES:

1. Cable, A.J. "Upgrade of Ballistic Ranges at AEDC, Status as of Oct 1993," AIAA-94-0542

AF95-007 TITLE: Pressure Indicating Paint for Turbomachinery Measurements

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop a full-coverage pressure-temperature indicating paint system for unsteady measurements on rotating turbomachinery blades.

DESCRIPTION: Determine turbomachinery blade surface steady and unsteady static pressure distributions under rotational speeds up to 30,000 RPM. Aerodynamic and aeroelastic stability and performance are dependent on the blade surface pressure distribution. Large adverse pressure gradients and large amplitude fluctuations can lead to aerodynamic and aeroelastic instabilities which are unacceptable. Designers need accurate surface pressure-temperature measurements as supporting information for new design theories. Better design methods will reduce the number of redesigns and tests resulting in substantial development cycle savings. One design and test cycle of a turbomachinery component can cost up to $10M. Benchmark data of blade surface pressures are critical to the advancement of turbomachinery design capabilities and are extremely difficult to obtain. This new technology would result in substantial savings to the Air Force and would have a direct impact on achieving Air Force propulsion goals in a cost effective and timely manner. The new technique should be low-cost, non intrusive, and should not compromise the structural integrity of the blade.

PHASE I: Identify the range of scientific issues that need to be addressed to incorporate this capability in a high-speed turbomachinery environment. Preliminary experiments will also be conducted in a low-speed rotating rig during this phase of the research program.

PHASE II: Resolve the basic science and chemistry issues as identified in Phase I. Any new issues related to high-speed flows will also be addressed, as well as testing the new technique on a high-speed compressor or turbine stage, such as exists at Wright Laboratory, Wright-Patterson Air Force Base.

COMMERCIAL POTENTIAL: As conceived, the end product will be a powerful measurement techniques with wide applicability in the commercial and military gas turbine community.

REFERENCES:

1. Hamner, Campbell, Liu, and Sullivan, "Scanning Laser Systems for Temperature and Pressure Sensitive Paint." 32nd Aerospace Sciences Meeting, AIAA Paper No. 94-0728, January 10-13, 1994, Reno, Nevada.

2. Campbell, Liu, Hamner, and Sullivan, "Temperature Sensitive Fluorescent Paint Systems," 25th AIAA Fluid Dynamics Conference, AIAA Paper No. 94-2483, June 20-23 1994, Colorado Springs, Colorado

AF95-008 TITLE: Composite Reinforcing Fiber and Interfacial Coating Processes

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop new process for producing ceramic fibers and applying interfacial coatings.

DESCRIPTION: Both ceramic and metal matrix composites are dependent on ceramic fibers to act as a continuous reinforcing phase, providing toughness and elevated temperature strength to the matrix. A crucial barrier to future consideration of new ceramic and metal matrix composites is the availability of these ceramic fibers and the interfacial coatings placed on them. A number of ceramic fibers have been demonstrated to be viable in ceramic and metal matrix composites. However, few useful fibers such as SiC, can be manufactured commercially; and these are limited in their compatibility with a variety of matrices. Other fibers are either prohibitively expensive, or not producible with current technology. Potentially viable fibers envisioned for use in ceramic and metal matrix composites include yttrium-aluminum garnet (YAG), Ti_5Si_3, TiC and TiB_2. Innovative processing methods are sought to produce economical ceramic fibers with good composition control and consistent mechanical

properties. Techniques to efficiently apply interfacial coatings with adherence to a ceramic fiber and uniform compositional control are also desired.

PHASE I: Develop a process for the production of inexpensive continuous ceramic fibers or interfacial coatings to be used in metal matrix or ceramic matrix composites. The process should demonstrate the ability to produce fibers or interfacial coatings which are thermochemically stable in their intended matrices and have desirable mechanical properties. The potential for scale-up of a proposed fiber or interfacial coating process must be demonstrated in this phase of the program.

PHASE II: Refine the fiber of interfacial coating process to concentrate on process scale-up towards continuous commercial production capability. Improvements in fiber and/or coating quality and reduced production cost are to be a prime focus during this phase.

COMMERCIAL POTENTIAL: Wide application in commercial sector for improved industrial processes in the manufacture of ceramic fiber composites.

REFERENCES:

"Metal/Intermetallic-Matrix Composites for Aerospace Propulsion and Power Systems," J. Doychak, JOM, Jun 1992, pp. 46-51.

AF95-009 TITLE: Self-shielding Superconducting Solenoids

CATEGORY: Basic Research

DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop computer code to be used to optimize coil configuration for various applications in self-shielding superconducting solenoids.

DESCRIPTION: Superconducting sloenoids are used to produce very high magnetic fields. These fields are used for ion cyclotron resonance spectroscopy, for nuclear magnetic resonance (NMR) measurements, for ion trapping experiments, and increasingly for magnetic resonance imaging (MRI). One problem encountered by all these uses is that magnetic field changes in the room where the superconducting solenoid is located can spoil the accuracy of the measurements. Field changes can be caused by subways, elevators, and passing trucks among other things. A self-shielding superconducting solenoid has been invented and patented that can reduce field fluctuations by a (measured) factor of 156. The inventor's design is now commercially available. However, only one coil configuratiion has been determined (by the inventor) and only that configuration is commercially available. Ideally the coil configuration should be matched to the use. Therefore a versatile computer code is needed for optimizing the design for any given end use configuration.

PHASE I: Develop the computer code for optimization, either on a very fast PC or a moderately priced workstation, and show that this general program could reproduce the experimental results already obtained by the inventor.

PHASE II: Would involve two objectives. First, extensive calculations on a variety of solenoid geometries would be carried out using a workstation dedicated to the project. Second, a company could actually produce the self-shielding solenoid system for the commercially most viable application, based on one of the newly calculated designs.

COMMERCIAL POTENTIAL: Two products would result that have commercial potential: superconducting solenoid systems specific to specialized customers and applications could be marketed, and the computer code itself could be sold.

REFERENCES:

"Self-Shielding Superconducting Coil," Journal of Applied Physics, Vol 53, 5143 (1988)

AF95-010 TITLE: Nitride Based Materials for High Temperature Electronics

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop single crystal semiconductor materials based on the III-V nitrides for electronic devices operating at high ambient temperatures.

DESCRIPTION: Current and future DOD application in airborne radar, electronic warfare, communications systems, nuclear-powered space vehicles, satellite power conditioning, integrated engine electronic, and 'smart skins' in hypersonic vehicles will require increasingly higher temperature conditions for efficient operation. The interpretation adopted for high temperature electronic materials is semiconductor materials suitable for the fabrication of electronic devices capable of operating at temperatures well in excess of the current Military Specifications (mil spec) temperature limit (125 C). The materials addressed in this program need to promise device and circuit operating performance at 300C and beyond. This requirement leads to the consideration of wide bandgap semiconductor materials to include the III-V nitrides such as AlN, GaN, c-BN and ternary and quaternary systems thereof, including InGaN. The long term interest in the wide bandgap materials appears to favor the nitrides with their intrinsic advantages in physical hardness, radiation hardness, low leakage and low dark current, large hererojunction offsets, high temperature capability high charge carrier velocity, low dielectric constants, and high thermal conductivity. Emphasis will be placed on innovative, highly relevant research efforts addressing such issues as stoichiometric growth, availability of lattice matched substrates, native defects, dopant activation, contacts, and material processing. Research is desired (but not limited to) in the area of lattice matched substrates using approaches which include large area bulk growth; optimized buffer layers on sapphire or other substrates; availability of better lattice and thermally matched SiC substrates and possible ZnO, MgO, BP, transition-metal and rare-earth nitride substrates; and novel approaches including nitride alloys, sacrificial substrate etching, and lift-off techniques. Novel concepts in boron-nitride alloys and SiC alloys (AlGaSiCN) and A1N:SiC heterojunctions may be addressed.

PHASE I: Research to advance the state-of-the-art of the III-V material base which will allow device operations at 300 C and well beyond and which will advance the commercial availability of substrates and epilayers of this wide bandgap material. Feasibility must be demonstrated for a particular approach and/or material.

PHASE II: Focus on the demonstration and optimization of materials growth, characterization, and device fabrication to verify its validity for high temperature operations.

COMMERCIAL POTENTIAL: Will have wide application in industries involved in propulsion, petroleum, space and computer development and manufacturing. Will also impact optical communication, storage, and detection.

REFERENCES:
S. Strite and H. Morkoc, "Gan, A1N: A Review," Journal of Vacuum Science and Technology, B 10(4), Jul/Aug 1992, pp. 1237-1265.

AF95-011 TITLE: Ultrafast Electronic Diagnostics and Testing for AF Electronic Warfare Systems

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Ultrafast electronic measurement instrumentation through further research and integration of recent basic research advances.

DESCRIPTION: Currently, military and civilian electronics systems can be made to operate at speeds that available diagnostics and test instruments cannot cope with, making diagnostics and testing virtually impossible, and greatly inhibiting further development and deployment. This topic seeks to overcome these problems by further research, development, and integration into new ultrafast electronic instrumentation, of advances that have resulted from AF and other basic research investments over the past decade. Examples of these advances are picosecond pulse generating Nonlinear Transmission Lines (NLTL's) and Resonant Tunneling Diodes (RTD's), picosecond aperture sampling bridges, and 200 Ghz- photdidode/sampler integrated circuits. This program seeks to integrate these and other high-performance technologies to create new high speed instrumentation at low cost, with novel integrated circuits topologies. Maximum integration of the above, or other advanced devices will not only increase circuit speed, but also allow more sophisticated trigger circuitry, reduced die size and simplified packaging. Indeed, if inputs are optical signals, no high-bandwidth electrical connections would be required, allowing a system to achieve up to the full 200-GHz bandwidth noted above. A major objective of this program is to overcome throughput limitations of conventional high-speed sampling oscilloscopes, making possible many new applications, for example, rapid recording of timing errors in optical communications systems or of complex modulated microwave systems.

PHASE I: Develop detailed designs and show feasibility of critical concepts.

PHASE II: Develop and demonstrate complete prototype instruments and demonstrate that they meet goals and specification originally targeted.

COMMERCIAL POTENTIAL: New products (test equipment) and new evaluation processes available for use by the electronics industry.

REFERENCES:

Bloom, David M., "Subpicosecond Electronics Sampling," Jan 1993, AD Number A264635

AF95-012 TITLE: Human Systems/Subsystems Research

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop innovative human-related systems or subsystems for aerospace applications.

DESCRIPTION: Proposers may submit ideas to enhance human performance as an integral part of Air Force systems and operations. Five directorates perform a full spectrum of basic and applied research including exploratory and advanced development: (Specify subtopic by letter).

a. The Human Resources Directorate conducts research in manpower and personnel, force management, training systems (including pilot training) and logistics/information technologies. The objective is to improve operational readiness and control costs by developing technologies for more effective selection, assignment, training and retention of a high quality military force.

b. The Crew Systems Directorate conducts research to assure optimal man-machine integration. Goals include understanding the limitations of humans to mechanical stresses (noise, vibration, acceleration, and impact), providing design criteria for weapon system development/enhancement, proposing protection devices, and improving human/weapon system interface.

c. The Aerospace Medicine Directorate addresses the medical selection, protection and enhancement of humans in Air Force systems and operations. Mission-related research and specialized operational support are conducted in aeromedical consultation, epidemiology, drug testing, and hyperbaric medicine. Clinical sciences research is conducted to develop standards for aviator selection and retention.

d. The Occupational and Environmental Health Directorate assesses risks to personnel from hazardous materials, noise, electromagnetic radiation, and occupational processes and conducts research to reduce those risks. The goal is to mitigate impacts on health and to enhance the scientific understanding of the underlying biological mechanisms.

e. The Environics Directorate conducts research on the environmental behavior, transport, and ultimate fate of chemicals in air, soil, or water; advanced containment characterization and pollutant monitoring technology; destruction of pollutants including biodegradation as well as physical chemical means; contamination cleanup technologies; hazardous waste minimization for processes of significance to the Air Force and new and innovative concepts to eliminate, substantially reduce, or mitigate environmental consequences of Air Force operations.

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AF95-013 TITLE: Removal of Scrap Dental Amalgam from Waste Water

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop technology to remove dental amalgam from waste water to allow compliance with mercury discharge limits.

DESCRIPTION: Scrap dental amalgam rinsed or suctioned from a patient's mouth during removal or placement of an amalgam restoration ends up in the waste water leaving the dental clinic and enters the public sewer system. Local water boards, at the direction of the federal law (Title 40 Code of Federal Register 403.5 (C)(1), available in any law library), have established limits for how much mercury can be present in waste water entering the public sewer system. Since dental amalgam is approximately 50 percent mercury by weight, it is the source of mercury found in the waste water leaving dental clinics and entering the public sewer system. Many local water boards have established very low limits, typically 50 parts per billion (ppb)of mercury (Norfolk, Virginia), for waste water entering the public sewer system. Unless reliable technology can be developed to remove the dental amalgam from waste water, it will have to be collected and disposed of as hazardous waste. If virtually all the dental amalgam and hence the mercury can be removed from waste water leaving dental clinics, the recovered dental amalgam could be recycled and the rest of the waste water returned to the public sewer system. This would not only avoid generation of a hazardous waste but also permit recycling of the silver and mercury found in the recovered dental amalgam. Existing technology based on centrifuges or sedimentation do not remove sufficient amalgam to meet most local limits. Other technologies such as ultrafiltration, electrolysis, or a combination of these methods has not been tried. In addition, currently available equipment suffers frequent break downs and needs improved reliability.

PHASE I: Phase I will identify a technology or combination of technologies that can reliably reduce the total mercury content of waste water collected from a dental clinic to below 50 ppb as measured using EPA test methods 3010 (acid digestion) and 245.1 (mercury) regardless of the initial mercury content of the waste water.

PHASE II: Phase II will result in development of hardware capable of accomplishing the required mercury removal to be tested in a dental clinic.

COMMERCIAL POTENTIAL: The technology developed could be used in both civilian and DoD dental clinics. DoD dental clinics tend to have more operatories and thus produce more amalgam waste than typically smaller civilian dental clinics but the same technology would be applicable to both situations.

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McCann, Daniel., "Another Regulation? State, Local Officials Scrutinizing Amalgam Waste in Water Supplies", ADA News, 25 (4), page 1.

AF95-014 TITLE: Noninvasive Blood Gas and pH Probe

CATEGORY: Basic Research
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop noninvasive probe for determining clinical blood and other tissue gas/pH ranges.

DESCRIPTION: Healthcare providers universally lack the technological ability to accurately and noninvasively determine the partial pressure of oxygen (paO2) and other gases, i.e., carbon monoxide (CO) and carbon dioxide (CO2), in arterial or venous blood and other deep tissues, or wounds, in sick patients. Basic noninvasive technologies (oxygen dosimetry, Marquette TRAM monitor) currently exist and provide physicians with clinical data, via monitors/pads attached to the skin, such as the percent oxygen saturation of red blood cells and heart, EKG, and respiratory rate. These data are clinically important in determining patient status but more useful information is needed, particularly in patients receiving hyperbaric oxygen therapy (HBO). For HBO patients, oxygen saturation is unimportant because of the elevated levels of dissolved oxygen in body fluids - red cell saturation is maximized and becomes irrelevant data. A device is needed that measures clinical parameters without touching the subject. It should be technologically inclined to provide a variety of clinical data. There is a need for a noninvasive probe that may be placed near, but not on, the patient or the patient's wound, to measure the partial pressure of dissolved oxygen in the interstitial body fluids. It should be capable of assessing gas pressure levels in a graduated fashion from superficial to deep, in

both healthy and compromised tissues. Other relevant gases, such as CO2 and CO, should be measured because they are also clinically important in certain patients, i.e., CO poisoning. Additionally, blood and deep tissue pH, degree of tissue granulation, and degree of eschar thickening are useful data to measure and use in conjunction with the blood/tissue gas levels. In follow-on efforts, data collected from this probe would drive, or control, therapeutic devices and instrumentation specifically tailored to each patient - instrumentation feedback.

PHASE I: This effort will identify and develop different basic technologies which may serve as probe candidates. Basic research is needed to develop and test various noninvasive probes and probe technologies for assessing clinical ranges in battlefield, Nuclear Biological Chemical (NBC), and hypo-/hyperbaric environments. Instrumentation should be developed in conjunction with appropriate computer support to analyze patient data derived from the probe and respond by altering therapeutic devices to improve the patient's health status.

PHASE II: Phase II will test promising noninvasive probes and supporting instrumentation which must provide patient data that is accurate to within two percent of data generated from using invasive evaluation reference techniques.

COMMERCIAL POTENTIAL: Critical and noncritical patients under the care of physicians and nurses, both military and civilian, in any environment will benefit from this technology. The primary value is in quickly assessing and caring for emergency patients. Applications could be made to healthy persons placed in compromising environments (firefighters, chemical defense ensembles, bioenvironmental hazards, aircrews, altitude chambers, etc.)

REFERENCES:

Swanson, C.J. & Wingard, C. 1991 Quantitative Thermal Gradient Imaging of Biological Surfaces, Journal of Photo-Optical Engineering, Vol. 1467, pp.372-382.

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AF95-015 TITLE: Enhanced Research Capability for the Advanced Spatial Disorientation Demonstrator (ASDD)

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Upgrade current ASDD hardware/software to make it a state-of-the-art research facility.

DESCRIPTION: The ASDD is an advanced motion-based simulator with a wide-field-of-view computer visual system designed to support ground-based spatial orientation training. The ASDD has a gimbaled, full-motion capability in all three angular planes, and can generate up to 2.2-G of centripetal acceleration. Although the ASDD is adequate for basic training purposes, it must be upgraded in several respects in order for it to support advanced research in the areas of motion perception, visual-vestibular interactions, visual symbology evaluation, and other types of spatial orientation-related research. Existing needs are to identify and implement the technological improvements required to support state-of-the art spatial orientation research with the ASDD. Included in any initial evaluation process would be an analysis of the current feasibility of any recommended upgrades. Areas in which research upgrades would be highly desirable include but are not limited to: (a) installation of a six-degree-of freedom head-tracking capability, to allow for accurate head positioning within a continually changing motion environment and off-axis gravitoinertial force-fields and to permit the incorporation of head-mounted displays into the ASDD cockpit; (b) faster visual graphics processing, achieved by incorporation of state-of-the-art low-end (<$200K) graphics computers; (c) distortion correction for the visual scene, to allow for accurate and conformal visual rendering on a quasi-spherical surface; (d) expanded data acquisition and storage capabilities, including the possibility of adding more data lines from the ASDD to the system computer and using optical slip ring technology to reduce transport lag; and (e) refinement and expansion of the aero and motion simulation models currently driving the ASDD's motion base and visual system, to make use of the unique planetary yaw capability of the ASDD. Documentation required for project completion is available from AL/XPT, 2509 Kennedy Circle, Brooks AFB TX 78235-5118, (210) 536-2103.

PHASE I: Phase I will result in the identification and evaluation of the technological improvements required to make the ASDD a state-of-the-art spatial orientation research device. Technically feasible upgrades will be recommended for the Phase II effort, and a detailed road map for implementing them will be provided.

PHASE II: Phase II will result in the implementation of selected software and hardware research upgrades to the ASDD, including (but not limited to) many of those identified by the Phase I effort. Some of these upgrades may require original design and testing. Demonstrations will be required.

COMMERCIAL POTENTIAL: Spatial disorientation is a problem for both general and military aviation, and it is likely that ASDD-type devices will be used by the private aviation industry in the near future. Many of the research upgrades will also be applicable in the generation of high-fidelity virtual reality systems in industry and entertainment. In particular, the capability to overcome spherical distortions in a computer-generated visual scene using a low-end computer system has not yet been achieved, and will be a major breakthrough if it is attained in this project.

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Gillingham, KK (1992). "The spatial disorientation problem in the United States Air Force," Journal of Vestibular Research, Vol. 2, pp. 297-306. Unclassified. Distribution Unlimited.

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AF95-016 TITLE: Chemical Biological Warfare Defense Detection and Decontamination Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Chemical & Biological Systems
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop novel technology and methodology that will detect, identify, quantify and decontaminate biological/chemical agents.

DESCRIPTION: This requirement is for novel methods and technologies to detect, identify, quantify, and decontaminate highly toxic chemicals and pathogens.

a. A need exists for a continuous monitor to rapidly identify and warn of the presence of chemical agents in either liquid or vapor phase.

PHASE I: Phase I will result in the design and fabrication of a laboratory prototype system to detect, identify, and quantify nerve and blister agents in either a vapor or liquid phase.

PHASE II: The Phase II will optimize the detector system, laboratory and field test it against simulants and at least two agents, and fabricate a breadboard for testing at a designated facility.

b. There is also an Air Force need to produce a biological warfare (BW) detector for harmful bacteria, viruses, and biotoxins. Current efforts will probably result in a good detection capability for bacteria and reasonable detection capabilities for viruses and toxins. However, virus and toxin detection is more cumbersome for the instruments currently in development. Thus, other novel technologies are solicited for the rapid, reliable, and sensitive detection of viruses and toxins. The optimum technology should be automated or easy to use, man portable, and have a low reagent and power requirement.

PHASE I: Phase I will result in a proof-of-concept type demonstration of the technology which will illustrate the rapid, selective, and sensitive detection capabilities of the prospective technology using simulant viruses and toxins.

PHASE II: Phase II will produce a prototype device and more in-depth evaluation of the device characteristics.

c. This requirement is to develop a novel but simple and facile method to rid aircraft interiors and other equipment (difficult to decontaminate) of chemical and biological threat agents. The optimal technique will involve an inexpensive material and/or device, highly mobile and effective against a wide variety of chemical and biological threats, non toxic to personnel, environmentally safe, rapid, that will not degrade aircraft interior materials.

PHASE I: Phase I will result in design and fabrication of a laboratory prototype system which shall demonstrate the proof-of-principle with the use of chemical and biological agents and simulants.

PHASE II: Phase II will require an in-depth analysis of the technology in a real aircraft and large-scale production of reagents or related analogs with different properties or production of a prototype device for chemical and biological decontamination.

COMMERCIAL POTENTIAL: This technology applies to environmental protection, clinical diagnostic, and therapeutic areas.
a.) Technology may be applied to on-site continuous monitoring of various industrial environmental pollutants.
b.) Technology can be used as a blood clinical diagnostic system or a hospital operating room monitor.
c.) Technology may be applied to on-site contamination control of industrial environmental pollutants.

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Bond, W.W., et al: "Dry Heat and Inactivation Kinetics of Naturally Occurring Spore Population," Applied Microbiology Vol. 20, pp. 573-578. Unclassified. Distribution Unlimited.

Bruno, J.G. and Kiel, J.L.: "Biological Immunomagnetic Aerosol Sensor; BIAS," AF Invention No. 20851 (U.S. Patent Pending). Unclassified. Distribution Unlimited.

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Ferguson, F.E., et al: "Analysis of VX and GB Brine by Gas Chromatography/Ion Trap Spectroscopy," CRDEC-TR0029, United States Army Chemical Research Development and Engineering Center, Aberdeen Proving Ground, MD, January 1989. Unclassified. Distribution Unlimited.

AF95-017 TITLE: Defining Human Factor Stress In Agile Flight

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects

OBJECTIVE: Define acceleration stresses that humans experience during specific agile flight maneuvers of high performance aircraft.

DESCRIPTION: With the advent of the F-22 and other agile aircraft, humans will be exposed, for the first time, to complex acceleration fields that will affect their performance as well as how they use equipment in the cockpit. The three-axis Dynamic Environment Simulator (DES) has been simulated on a computer and is presently being programmed for agile flight studies. Research opportunities exist to better define the environmental stress that affects a pilot as he/she rides the DES as well as planning better methods to apply this AF resource to the next generation of agile aircraft.

PHASE I: Using simulation software such as MAPLE, SIMULINK, etc., develop a symbolic type computer model of the DES which has as inputs, the agile flight profiles. The output of this model is the actual accelerations experienced by human subjects in the DES. This model will incorporate DES actuator dynamics and other information supplied by the Armstrong Laboratory. It is important to identify which supermaneuverable profiles can be realized on the DES motion simulator and to measure the simulation fidelity.

PHASE II: A model validation will be conducted by comparison of the model's output to the actual response of the DES centrifuge. By varying the fixed parameters of the centrifuge simulator in the computer model, optimum fixed parameters can be obtained to improve the fidelity of the simulated motion fields.

COMMERCIAL POTENTIAL: The symbolic computer program developed would be applicable in the design of motion simulator systems for civilian aircraft. Using this simulation technique, research can be conducted prior to building specific designs to check the efficacy of a specific design. These checks are commonly done by building and testing prototype structures in a wind tunnel. It is far less expensive to change simulation parameters and conduct simulation modeling than to run a full prototype test program. The simulation helps weed out undesirable prototyping scenarios before valuable time and other resources are used up with poor prototype evaluations.

REFERENCES:
Repperger, D.W., 1992, "A Study of Supermaneuverable Flight Trajectories Through Motion Field Simulation of a Centirfuge Simulator", Trans. of the A.S.M.E. Journal of Dynamics Systems, Measurement, and Control, Vol. 114, 1992, pp. 270-277. Unclassified. Distribution Unlimited.

AF95-018 TITLE: Advanced Audio Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Enhance audio systems in Air Force operational environments.

DESCRIPTION: A requirement exists for effective voice communications, crew safety, and human performance that are based on natural, intuitive interfaces using innovative abilities and requiring no learning or training for efficient operation. The intuitive interfaces facilitate operator task performance, reduce workload and fatigue, and improve personal safety. These intuitive interface technologies include but are not limited to: 1) auditory system modeling and neural networks for robust signal processing of speech; 2) digital audio technology to allow integration into aircraft systems; 3) voice communications countermeasures/counter-countermeasures; 4) noise-induced hearing loss protection; 5) active noise reduction; and 6) 3-dimensional auditory display for spatial awareness and communications.

PHASE I: Phase I efforts would provide an assessment of the state-of-the-art and an approach to develop an appropriate intuitive audio interface technology.

PHASE II: Phase II efforts would provide a demonstration and validation of the intuitive audio interface technology.

COMMERCIAL POTENTIAL: Commercial applications of these technologies include commercial aviation (Air Traffic Control, Collision Warning), entertainment, industrial safety, and the health care fields.

REFERENCES:

Anderson, Timothy R., "A comparison of suditory models for speaker independent phoneme recognition," IEEE Proc. Int. Conf. on Acoustics, Speech, and Signal Processing, Vol II, pp. 231-234, Minneapolis, April 1993. Unclassified. Distribution Unlimited.

DeSimio, Martin P. and Anderson, Timothy R., "Phoneme Recognition with Binaural Cochlear Models and the Stereausis Representation," IEEE Proc. Int. Conf. on Acoustics, Speech, and Signal Processing, Vol I, pp. 521-524, Minneapolis, April 1993. Unclassified. Distribution Unlimited.

McKinley, Richard L., Ericson, Mark A., and D'Angelo, William r., "3-D Auditory Displays-Development, Applications and Performance," to appear in Journal of Aerospace Medicine, May 1994.

Nixon, Charles W., McKinley, Richard L., and Steuver, Joseph W., "Performance of Active Noise Reduction Headsets," in Noise Induced Hearing Loss, Dancer, Henderson, Salvi, and Hamernik, editors, Mosby Year Book, Inc., pp. 389-400, 1992. Unclassified. Distribution Unlimited.

AF95-019 TITLE: Color-Corrected Binocular Optics for Subtractive-Color Liquid-Crystal Display

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Design binocular helmet display optics that image a subtractive-color LCD with minimal chromatic aberration.

DESCRIPTION: The modern Air Force's need for power projection anywhere on the earth implies that future strike and counter air missions will need the capability to integrate information from many remote information sources and target weapons at long range either day or night. A full-color helmet display can aid information integration significantly through color coding. Subtractive-color liquid-crystal displays (SCLCDs) produce full color without sacrificing resolution and, therefore, can provide the pilot with an all-in-one display system capable of acting as an appropriate information source for any conceivable input. However, SCLCDs have a limitation that greatly complicates the design of the helmet display optics: each of the three color primaries is generated in a different image plane. It is difficult enough to achieve lightweight helmet display optics that provide good chromatic aberration performance over the entire 360-830-nm visible spectrum when all primaries emit from the same plane. The problem becomes more difficult when the primaries are formed in image planes that are displaced slightly in a longitudinal direction from each other. No helmet display optics currently exist for fighter aircraft applications that can provide the desired longitudinal and lateral chromatic aberration performance. This effort will determine if such a system can be designed and built.

PHASE I: The Phase I effort shall demonstrate whether suitable lightweight helmet optics can be designed that also appear to be manufacturable.

PHASE II: The Phase II effort will proceed with the fabrication and test of engineering prototype optics that shall demonstrate operation with a full-range SCLCD.

COMMERCIAL POTENTIAL: Numerous commercial uses including virtual reality, Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) modeling, architectural design, and medical imaging exist if such a system could be developed and built.

REFERENCES:

Conner, A.R., Biles, J.R., and Jingsley, G.B. (1993). Ultimate limitations of subtractive color systems. Proceedings of Eurodisplay, 167-170/ Inclassified. Distribution Unlimited.

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AF95-020 TITLE: Fluid Dynamics Modeling for Helmet-Mounted Displays

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Design Automation

OBJECTIVE: Model airflow behavior for the improvement of aerodynamic/structural design of future helmet-mounted displays.

DESCRIPTION: Wind blast testing provides valuable data in the qualification of ejection capable helmet-mounted display (HMD). The Air Force has performed ejection compatibility tests on several HMDs as part of the air worthiness certification process. The HMD was subjected to wind blasts simulating ejections up to 600 knots. Preliminary data show that helmet shape is an important factor in determining the direction and amount of force exerted on the helmet (and presumably on the pilot's neck). Furthermore, the airflow pattern around the ejection seat reveals any disruption that may interfere with the pitot tube airspeed sensing mechanism and prevent proper deployment of the parachute. However, wind blast testing requires the building of costly hardware prototypes and the availability of expensive wind tunnel and/or wind blast facilities (upwards of $80K to $100K per helmet configuration run). This effort will use Computational Fluid Dynamics (CFD) and visualization techniques to create a virtual wind tunnel/wind blast environment so that flawed HMD designs can be corrected without the expense of actual hardware building and testing. Another possible usage of this virtual environment is to aid the design of frangible HMD as a means to meet safe weight/CG requirements. The trajectory of a breakaway is not always known or predictable to the designer. This modeling tool will enable the designers to examine the effects of different disengagement latches and timing combinations to insure maximum pilot safety and compatibility with the entire escape sequence. Several HMD profiles and air crew anthropometric databases that already exist in a Computer Aided Design (CAD) environment (but not in finite element format) will be provided in Phase I.

PHASE I: The Phase I effort shall demonstrate the applicability and feasibility of computational fluid dynamics (CFD) for modeling turbulent airflow around a helmet-mounted display (HMD) in free stream conditions after canopy jettison.

PHASE II: The objective of Phase II is to implement and validate CFD software on a PC-networked platform. Some effort shall be devoted to speed optimization for targeted processors and packaging for commercialization.

COMMERCIAL POTENTIAL: The resulting CFD and visualization techniques will enable computer-aided-design and make virtual-prototyping a reality. Current CFD methods and techniques which rely on the fastest super computers is beyond reach by ordinary bicycle helmet, ski goggle, or rescue hoist designers. Another far reaching application for this technology is to combine it with full-motion video capturing as a virtual wind tunnel for athletic training.

REFERENCES:

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Person, C.W. (1993) The fluid physics of parachute inflation, Physics Today, August, 1993, 32-39. Unclassified. Distribution Unlimited.

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AF95-021 TITLE: Subsurface Introduction of Microorganisms

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop methods for inoculation of microorganisms to enhance biodegradation of chlorinated solvents.
DESCRIPTION: The introduction of specialized microorganisms into the subsurface could enhance the biodegradation of chlorinated solvents like trichloroethylene (TCE) that resist biodegradation by native microorganisms. To effectively degrade contaminants in the subsurface environment, microorganisms must be transported to the contaminated zone, survive environmental factors, be adherent to the subsurface material, and maintain degradative capabilities.

PHASE I: Phase I will develop a novel method (bench-scale) for transporting microorganisms into the subsurface and be capable of maintaining conditions conducive to survivability and TCE degradation.

PHASE II: Phase II will implement the development and testing of this novel process utilizing specialized microorganisms (regulatory approval required) at a TCE contamination site and determine the benefits of introduced microorganisms.

COMMERCIAL POTENTIAL: Full-scale development and commercialization of an in-situ bioremediation technology is applicable to the chemical industry, dry cleaners, aircraft manufacturing or any industry using solvents.

REFERENCES:
Crawford, Ronald L. and Stormo, Keith, "Stabilization of Microorganisms for In Situ Degradation of Toxic Chemicals" U.S. DOE/ER/60847-2, March 1, 1991. DE92 040792. Unclassified. Distribution Unlimited.

DeFlaun, Mary F. and Ensley, Burt D., "Development of Adhesion-Deficient Trichloroethylene (TCE) Degrading Bacteria for In Situ Applications". 1993 ASM Annual Meeting. Unclassified. Distribution Unlimited.

AF95-022 TITLE: Recovery, Treatment, and Recycling Technologies for Metals in Industrial Wastewater

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Provide cost effective, efficient, and compliant treatment method for regulated heavy metals in industrial wastewater.

DESCRIPTION: The Air Force Air Logistics Centers (ALCs) need methods to recover target heavy metals from industrial wastewater. Each such method must reduce the metal content to a level that is within federal, state, and local standards for release into receiving waters or sludge discharge into a municipal landfill. The metals of primary concern are hexavalent and trivalent chromium, and nickel. Other metals of slightly lesser concern are cadmium, lead, copper, and zinc. This technology should not produce another hazardous waste as a result of the process, but should concentrate the metals in volume and in a form that will make recycling possible. Innovative, cost effective, and high volume approaches have the greatest potential for selection.

PHASE I: Phase I would demonstrate that the technology does indeed remove the metal contaminants to levels that are within the bounds of federal, state, and local legislation.

PHASE II: Phase II technology should be refined so that the residence time of the selected technology can be reduced to a level where it is feasible for use with large quantities of industrial wastewater (i.e.,wastewater from an ALC) and provide sufficient data that could lead to the development of a prototype.

COMMERCIAL POTENTIAL: Applications of the technology include automotive, aerospace and electronics industries as well as anyone dealing in waste water. Metals recovery from plating, stripping, and coating operations will save millions of tax dollars from both materials costs through recycling and the costs of sludge disposal in a hazardous waste landfill.

REFERENCES:

Peters, R.W., Ku, Y., and Bhattacharyya, D., "Evaluation of Recent Treatment Techniques for Removal of Heavy Metals from Industrial Wastewaters," AICHE Symposium Series, No. 243, 81, 165-203 (1985).

AF95-023 TITLE: New Chemometric Techniques for Analytical Chemistry and Sensor Data

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop novel chemometric techniques for the evaluation of environmental analysis data.

DESCRIPTION: Chemometrics are statistical and mathematical techniques used to interpret chemical analysis data. Existing chemometric techniques can classify samples based on analytical profiles, estimate pollution contributions from mixed sources, deconvolute absorption spectra from mixtures, and they can perform other tasks. The performance of any chemometric analysis may depend upon the use of a number of statistical techniques to condition or preprocess the data as well as final techniques to perform the desired classification, source apportionment, or deconvolution. Chemometric calculations are nearly always performed by computer, since large and complex data sets are usually involved. The development and validation of new chemometric techniques involves the mathematical formulation of the calculation, verification from mathematical and statistical principals that the proposed calculation is valid, expression of the calculation as computer software, and the demonstration with actual data sets. Large volumes of data are generated by conventional analytical techniques such as gas chromatography, infrared spectrometry, and mass spectrometry as well as by combined techniques such as gas chromatography/mass spectrometry (GC/MS). Additionally, novel rapid sensing techniques are under development, many of which generate combined analytical responses from environmental mixtures. The need for rapid data analysis and interpretation will continue and increase due to the emphasis for rapid analytical turnaround.

PHASE I: Formulate novel chemometric tools as mathematical formulations, express as computer software using either conventional programming languages or a symbolic mathematics language. The reported information must include both mathematical formulation of the method and source code for any computerized expression of the method. The proposed method can be demonstrated and tested with standard data sets or with newly collected information.

PHASE II: The method can be refined to operate more accurately and more efficiently. Necessary conditions for accurate use should be explored. During Phase II any finalized method should be expressed as computer programming. The ADA programming language, which is accepted by the Department of Defense, is recommended for this phase of development but other languages may be substituted subject to Air Force approval. The final method should also be tested and demonstrated using standard data sets and data sets from actual chemical analysis instrumentation.

COMMERCIAL POTENTIAL: Conventional analytical chemistry techniques such as chromatography and spectroscopy techniques are well established and are used for environmental monitoring, detection of impurities and adulteration in food and drug products, as well as for research in the environmental and biomedical fields. In addition there is a rapidly developing class of instruments termed sensors which provide data rapidly, but whose data require special mathematical interpretation to provide chemical identification and quantitation. The development of improved and validated chemometric techniques to aid in the analysis and interpretation of these data would be of general benefit to commercial laboratories, education institutes and technical consultants.

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AF95-024 TITLE: Develop Methods to Determine Fate of Chlorinated Hydrocarbons During Bioventing

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop methods to determine the fate of chlorinated hydrocarbons under cooxidative conditions during bioventing.

DESCRIPTION: Bioventing has been successfully applied to treat unsaturated soils contaminated with petroleum hydrocarbon fuels by stimulating in situ aerobic biodegradation. Many Air Force sites are co-contaminated with chlorinated solvents, (primarily trichloroethylene or TCE) in both the saturated and unsaturated zones. It is necessary to develop accurate methods to monitor the cooxidation of the chlorinated compounds in the subsurface during the bioventing process.

PHASE I: Phase I will provide innovative ideas for field methods to follow the fate of chlorinated hydrocarbons during the operation of a bioventing system. The method must also be capable of monitoring chlorinated hydrocarbon degradation by either detection of degradation intermediates or end products. Method results must distinguish between changes in contaminant concentration due to volatilization, dilution, and cooxidation. These methods must be field tested at a small-scale in Phase I.

PHASE II: Phase II will be the field operation of a treatment system at a mixed waste contamination site.

COMMERCIAL POTENTIAL: Full-scale development and commercialization of an in-situ bioremediation system would be of benefit to the chemical industry dry cleaners, aircraft manufacturing companies or anyone working with solvents.

REFERENCES:
"Test Plan and Technical Protocol for a Field Treatability Test for Bioventing", Air Force Center for Environmental Excellence (AFCEE), Brooks AFB TX, 1992. Unclassified. Unlimited. NTIS Publication Number PB93-209146.

AF95-025 TITLE: Methods for Separation of Contaminated, Detergent- Stabilized Oil-Water Mixtures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop new technologies to separate mixtures of oil, water, detergents, and solids, prior to reuse or disposal.

DESCRIPTION: A range of Air Force activities generate wastewaters containing oily substances, emulsion-stabilizing agents, and insoluble materials. Examples include wash racks and dumps of Aqueous Film-Forming Foam (AFFF) fire protection systems. Cost-effective disposal or reuse of the water and other components requires timely and efficient separation methods. Novel approaches are preferred.

PHASE I: Phase I effort should include an experimental demonstration of technical feasibility.

PHASE II: Phase II effort should include refinement of the technology into a process and a prototype, or better, full-scale demonstration of that process at an Air Force site to be selected in Phase I. The Phase II effort must provide sufficient data to support development of a prototype.

COMMERCIAL POTENTIAL: The crossover is direct and obvious. Many industries generate significant volumes of contaminated wash solutions requiring pretreatment before reuse or disposal, and this process will be directly applicable to many such applications.

REFERENCES:
Tramier, B., "Water Treatment Technology," Institute for Petroleum Technology Papers, IP 84-011 (1985).

Zeevalkink, J.A., and Brunsman, J.J., "Oil Removal from Water in Parallel-Plate, Gravity-Type Separators," Water Research 17(4), 365-373 (1983).

AF95-026 TITLE: Hydraulically-Driven Soil Probes for Monitoring and Characterization

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Combine real-time sensors with small, hydraulically powered soil probes to provide rapid site characterization/ monitoring.

DESCRIPTION: Popular characterization techniques such as monitoring wells are costly, labor intensive, and lengthy processes. Recently, cone penetrometers have been proposed and demonstrated for near real-time site investigations, providing subsurface soil stratigraphy and sensing capabilities for detecting contaminants. Cone penetrometers also have the capabilities to obtain groundwater and soil samples relatively quickly. Cone penetrometers may be able to penetrate to depths exceeding 150 feet, but are large, heavy vehicles. Smaller hydraulically driven units are available that are capable of being stored and operated from smaller vehicles and can sample soil and groundwater at depths of approximately 50 feet. The need is for these small, convenient probes to be equipped with real-time monitoring capabilities to determine contaminant types and concentrations and also to provide geological characteristics such as hydraulic conductivity, porosity or grain size. Completion of this project would deliver an inexpensive method for rapid characterization of a contaminated site or placement of permanent monitoring devices.

PHASE I: This project will determine if the combination of small, hydraulically-driven probes and real-time sensing technologies is achievable and feasible.

PHASE II: Design and demonstrate a complete unit at an Air Force site (to be determined during Phase I).

COMMERCIAL POTENTIAL: Results of this work can be applied to many restoration projects requiring inexpensive characterization of shallow contaminant zones or in the placement of permanent monitoring devices.

REFERENCES:
Joseph, Hose P., "Biosensor Theory and Applications: Part II", Sensors, July 1993, pp. 23-26. Unclassified. Distribution Unlimited.

Stanker, Larry, Vanderlaan, Martin, and Watkins, Bruce E., "Environmental Monitoring by Immunoassay", ES&T, Vol. 22, No. 3, 1988. Unclassified. Distribution Unlimited.

AF95-027 TITLE: Chemical Reactor Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop chemical reactor technology for destruction or conversion of wastes.

DESCRIPTION: Novel and innovative chemical reactor technologies (including novel and innovative improvements to existing technologies) for destruction or conversion of hazardous wastes in treatment and disposal processes are needed. Hazardous wastes of interest include, but are not limited to, liquid and solid rocket propellants, explosives, other energetics, smokes, dyes, and other hazardous waste such as chlorinated waste materials and wastes contaminated by heavy metals.

PHASE I: In Phase I, a promising chemical reactor technology will be tested at the bench scale using representative waste material, either actual or surrogate. Associated unit operations, such as separation or effluent treatment, required for a complete treatment system must be identified. The experimental data should determine whether the technology is technically and economically useful for treatment of the target wastes.

PHASE II: In Phase II, the chemical reactor technology will be scaled up in a continuous system and destruction or conversion of additional waste materials in the targeted class will be tested. Experimental data generated should resolve significant technical questions and allow design of a scaled up reactor system.

COMMERCIAL POTENTIAL: The technology will be applicable to wastes from both DOD and commercial industrial operations such as the chemical processing industry, plastics/ composites manufacturing companies, and anyone dealing with complex chemical waste.

REFERENCES:
Buelow, S.J., et al, "Destruction of Energetic Materials in Supercritical Water," Interim Report, Air Force/DoE MOU DE-AI04-79AL11812, June 30, 1992.

Freeman, H.M., ed., "Standard Handbook of Hazardous Waste Treatment and Disposal," McGraw Hill, New York, NY, 1989.

AF95-028 TITLE: Residual Hydrocarbon Mass Transfer Rates

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop innovative approach for describing residual hydrocarbon mass transfer rates

DESCRIPTION: Mass transfer rates for residual hydrocarbons dissolving into groundwater are a poorly understood phenomena in need of more research. Since over 60 percent of USAF contaminated sites involve these residual phases, research should be directed at this problem. An understanding of mass transfer rates is critical to improved fate and transport codes used to describe movement of contaminants through aquifer materials. Remediation managers at contaminated sites make large-dollar decisions based on numerical models that use questionable source dissolution formulations. Improving the accuracy of underlying assumptions through an understanding of real mass transfer rates in these models will improve the end result of the model and provide better decision making capabilities.

PHASE I: Preliminary research defining mass transfer rates for residual hydrocarbons and Dense Non Aqueous Phase Liquids (DNAPLs).

PHASE II: Detailed large scale physical model experiments to form a data set for model testing and development.

COMMERCIAL POTENTIAL: Residual hydrocarbon contamination is not a DOD unique problem. Industries dealing with similar contamination problems will benefit from research results and data sets generated in this effort. Environmental consultant groups working the site remediation issues will use the data to improve their own modeling work.

REFERENCES:
Guiger, N., "Numerical Modeling of the Fate of Residual Immiscible Fluids in Saturated Porous Media," Water Science and Technology, Vol. 24, No. 11, pp. 261-270, 1991.

Lesage, S. and Brown, S., "Observation of the Dissolution of NAPL Mixtures," Journal of Contaminant Hydrology, Vol. 15 (1994), pp. 57-71.

Mayer, A.S. and Miller, CIT., "The Influence of Porous Medium Characteristics and Measurement Scale on Pore-Scale Distributions of Residual Nonaqueous-Phase Liquids," Journal of Contaminant Hydrology, Vol. 11 (1992), pp. 189-213.

AF95-029 TITLE: Development and Presentation of Radio Frequency Dosimetry

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Design Automation

OBJECTIVE: Develop improved techniques for predicting and displaying radio frequency radiation dosimetry.

DESCRIPTION: The interaction of radiofrequency (RF) and microwave (MW) radiation with biological tissues is of increasing importance from the standpoint of the health and safety of Air Force personnel. Theoretical models of this interaction have been used to predict safe human exposure levels. However, the present model was developed from single-tissue properties prescribed for each 1.31 cm X 1.31 cm area of the anatomic cross sections that were available for separations on the order of 2.3-2.7 cm.

Interpolations were then used to obtain the compositions of the numerical cells for various intermediate locations. Linearly expanding grids will be used to prescribe properties for cell sizes as small as 1.44 mm for dosimetric calculations at 3 GHz resulting in more accurate specific absorption rate Specific Absorption Rates (SAR) distribution information. Magnetic resonance imaging tapes of the human body should be used to define the contours of the various organs and tissues for each of the cross sections of the body. Keeping the model flexible enough so that a dominant tissue could be prescribed for each of the cells likely to be on the order of a millimeter (mm) or so at higher frequencies will make it possible to use a look-up table of only 16 tissues. In addition to an accurate representation of the body at higher frequencies where cell sizes on the order of mm are needed, use of a 16-tissue look-up table would result in a considerable reduction in the memory requirement and hence the computation time for the code. The linearly expanding grid should be used with this high-resolution model of the human body to develop an atlas of SAR distributions for frequencies up to 6 GHz. SAR distributions shall be obtained for biologically sensitive regions such as eyes, brain, gonads, and others with resolutions on the order of mm and furnished on compact disks for use on PCs.

PHASE I: Phase I will result in the development of a computer representation of an anatomically detailed block model of a human.

PHASE II: Phase II will result in CD installable software for calculating and presenting radio frequency dosimetry performed on the model developed in Phase I.

COMMERCIAL POTENTIAL: This research is needed to more effectively present and more economically develop radio frequency dosimetry information to support research to assure safety of personnel from radio frequency fields. The techniques available on the resulting CDs are applicable to the dosimetry aspects of communication systems, radar, EMP, and ultrawideband emissions.

REFERENCES:
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Gandi, O.P., "Numerical Methods for Specific Absorption Rate Calculations," in, Biological Effects and Medical Applications of Electromagnetic Energy, O.P. Gandhi, Editor. New Jersey, Prentice Hall, 1990.

Dimbylow, P.J., "Finite-Difference Time-Domain Calculations of Absorbed Power in the Ankle for 10-100 MHz Plane Wave Exposure," IEEE Transactions on Bio-Medical Engineering, Vol. 38, No. 5, pp. 423-428, 1991.

Chen, J.Y., and Gandi, O.P., "Currents Induced in an Anatomically Based Model of a Human for Exposure to Vertically Polarized Electromagnetic Pulses," IEEE Transactions on Microwave Theory and Techniques, Vol. 39, No. 1, pp. 31-39, 1991.

Sullivan, D., "Three-Dimensional Computer Simulation in Deep Region Hyperthermia Using Finite-Difference Time-Domain Method," IEEE Transactions on Microwave Theory and Techniques, Vol. 38, No. 2, pp. 204-211, 1990.

AF95-030 TITLE: <u>Environmental Noise Research and Development Projects</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop improved capabilities for modeling subsonic and supersonic aircraft noise propagation.

DESCRIPTION: To comply with the requirements of the National Environmental Policy Act, the Air Force must predict the environmental effects of major changes in flight operations, including effects of supersonic and subsonic aircraft noise on humans, animals and structures. Changes for which the noise effects must be assessed include the introduction of new aircraft, moves of squadrons or wings to new locations and development of new training routes, military operations areas, special use airspace and weapons ranges. In order to use scientifically acceptable methodologies for modeling noise exposure and predicting the effects of noise exposure, research and development projects are being sought in the following areas:

a. Noise Monitoring: There is a need for a flexible noise monitoring system that can be deployed around air bases for validation of the noise environment, public awareness of noise mitigation efforts, and litigation resolution. Proposals are

sought on all aspects of noise data collection, from better instrumentation, collection procedures, public interface, and operations correlation to measured noise events.

PHASE I: Phase I will result in a demonstration of the new measurement capabilities or software for automated analysis.

PHASE II: Phase II will result in a full field demonstration of the noise monitoring system at an operational base.

b. Animal Noise Monitor: The Air Force has need for a noise monitoring system that can be attached to small and large animals for validation of the noise environment of a wide variety of species of animals that are affected potentially by noise from aircraft operations. Proposals are sought on all aspects of noise data collection, from better instrumentation, collection procedures, miniaturization of the monitor for use with small mammals, and correlation of the measured noise events to aircraft flight.

PHASE I: Phase I will result in a feasibility analysis with a demonstrated prototype for laboratory testing.

PHASE II: Phase II will result in full development and testing on several animal species in a rugged field environment.

c. Noise Modeling: The Air Force has need for better noise modeling capabilities to assess the impacts of subsonic and supersonic aircraft flight activity. Proposals are invited on all aspects of noise modeling, from better propagation algorithms, innovative weather and operations data collection, and noise contour plotting to interface with Geographic Information Systems.

PHASE I: Phase I will result in feasibility analysis for various noise sources, data collection systems or methodologies or improved plotting capabilities.

PHASE II: Phase II will result in fully developed noise modeling capabilities to be used to model civil as well as military noise sources.

COMMERCIAL POTENTIAL: The research and development efforts needed to predict and assess the effects of aircraft noise will result in technical capabilities that can be used by hundreds of acoustical consultants and contractor firms that support various federal agencies in addressing environmental noise issues. Agencies such as the Army and Navy, the Federal Aviation Administration, the National Aeronautics and Space Administration, the Department of Transportation, and the National Park Service all use commercial acoustics firms to perform acoustic analyses which could potentially use the products of the research and development sought under this solicitation. Zoning boards use it to specify land use.

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A. Bishop, Dwight E., Harris, Andrew S., Mahoney, Joan, and Rentz, Peter E. NOISECHECK Procedures for Measuring Noise Exposure from Aircraft Operations. AMRL-TR-80-45, November 1980 (AD-AO93948)

B. Murphy, S.M., White, R.G., Kugler B.A., Kitchens, J.A., Smith, M.D., and Barber, D.S. (1993). "Behavioral Effects of Jet Aircraft on Caribou in Alaska." Proceedings of the 6th International Congress Noise as a Public Health Problem, Vol. 3, pp. 479-486.

B. Bowles, A.E., McClenaghan, L., Francine, J.K., Wisely, S., Golightly, R., and Kull, R. (1993). "Effects of Aircraft Noise on Predator-Prey Ecology of the Kit Fox (Vulpes Macrotis)." Proceedings of the 6th International Congress Noise as a Public Health Problem, Vol.3, pp. 462-470.

AF95-031 TITLE: Method for Determining the Refractive Indices of Ocular Components

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop an apparatus to accurately measure refractive indices of ocular components in the living eye.

DESCRIPTION: With large cost increases in maintaining the quality of American health care, methods are sought which may show cost savings in the early detection and/or treatment of diseases. Presently Armstrong Laboratory is building eye models which require accurate values of the linear refractive indices for the eye. Research is required to find an accurate method to measure the refractive index of ocular media in the visible and near-infrared wavelength regime to five significant digits for each ocular component (i.e. cornea, aqueous humor, lens and vitreous humor) in a living eye without creating damaging effects in the eye. The data obtained from this method can be used to determine the presence of systematic changes of refractive index when disease is present. The method will also be used to collect data to determine the focusing characteristics of the eye in the near infrared spectral range. This procedure will help in establishing a model which accurately describes the spot size of radiation on the retina for different input characteristics.

PHASE I: Phase I will result in the feasibility, technical design and proof of design for an apparatus which will measure the refractive indices of ocular components in-vivo to five significant digits in the visible and near infrared spectral ranges.

PHASE II: Phase II will construct and test the apparatus on model eyes in a variety of wavelength regimes.

COMMERCIAL POTENTIAL: The measurement apparatus described could be used as a spectroscopic means to diagnose ocular disease if it is shown a change in refractive index of a certain ocular component was a precursor of these diseases. This technique can be used in determining the refractive error in eyes where the refractive indices lay outside normal parameters. It can also aid in the custom manufacture of corrective lenses and contacts.

REFERENCES:
Millodot, M., and Newton, I.A., "A Possible Change of Refractive Index with Age and Its Relevance to Chromatic Aberration." Albrecht von Graefe's Archive for Clinical and Experimental Ophthalmology, Vol. 201, No. 2, 1976, pp. 159-167.

Sivak, J.G., and Mandelman, T., "Chromatic Dispersion of the Ocular Media." Vision Research, Vol. 22, No. 8, 1982, pp. 997-1003.

Gilmartin, B. and Hogan, R.E., "The Magnitude of Longitudinal Chromatic Aberration of the Human Eye Between 458 and 633 nm." Vision Research, Vol. 25, No. 11, 1985, pp. 1747-53.

Kroger, R.H.H., "Methods to Estimate Dispersion in Vertebrate Ocular Media." Journal of the Optical Society of America. A, Vol. 9, no. 9, 1992, pp. 1486-1490.

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AF95-032 TITLE: Hand Held Sensor Device

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: A hand-held device for rapid collection and data retrieval in the field.

DESCRIPTION: A complete portable kit that can be used for such needs as the fate and transport of airborne chemical products with a wide range of environmental applications requiring very sensitive chemical detection capabilities. There is a need for a hand-held device for rapid data collection and data retrieval in the field. A Personal Digital Assistant (PDA) is suggested with a sensor on the end for data collection and appropriate displays and alarms for over threshold conditions. Sensors can include Surface Acoustic Wave (SAW) devices and Electrochemical devices to pickup contaminants or chemicals of interest down to possibly the parts-per-trillion level. The sensitivity of the detection systems is so great that fires can be accurately detected faster than a current smoke detector, illegal drugs or explosives can be detected in areas the size of stadiums. The PAD data can be downloaded to a personal computer or similar device for reporting raw data and for correlation of the raw data into a standardized reporting structure. The monitoring technology needs that can be met include Emission Control Technology, Instrumentation for Field Quantification for Semi-Volatile Media, Direct Reading Instruments, Clean Air Act Requirements Monitors, and a Portable Instrument to Measure the Source and Strength of a Chemical Spill.

PHASE I: Phase I will produce a documented proof of concept.

PHASE II: Phase II will result in a prototype hand-held device.

COMMERCIAL POTENTIAL: The complete kit can be used for such needs as the fate and transport of airborne chemical products that contain herbicides/pesticides, illegal drug detection at schools and public stadiums, illegal explosives/ordnance detection in controlled areas such as schools or airports, chlorinated solvent vapor treatment, expended propellant airborne plume fate and transport from rocket or weapons launches, early detection of natural gas leaks, a portable warehouse fire/smoke detector, detection of natural or unnatural botanical or animal species population in a given area, emission-control devices for industrial processes, and other very sensitive chemical detection requirements.

REFERENCES:
US Patent Number 5076094 (Dec 31, 1991); "Dual Output Acoustic Wave Sensor for Molecular Identification," Frye et al.

Clean Air Act (as amended) 42 USC-7401 et seq., Sec 103 Research, Investigation, Training, and Other Activity. Sec 114 Inspections, Monitoring, and Entry, Available from Government Printing Office.

Federal Insecticide, Fungicide, and Rodenticide Act, 7 USC-136 et seq., Sec 20. Research and Monitoring. Available from Government Printing Office.

Worker Protection Standard, PL 99-499, Oct 17, 1986, Section 126, Worker Protection Standards. Available from Government Printing Office.

AF95-033 TITLE: Aircrew Training Effectiveness

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop, demonstrate, evaluate, and transition dual- use aircrew training effectiveness techniques, technologies, and methods.

DESCRIPTION: Research is needed by DoD and other organizations in the area of aircrew training systems. Detailed information is available through the Defense Technical Information Center.

In current flight simulator visual displays a pilot often spots long distance targets first by a halo rather than distinguishing a high definition image. This and other disadvantages of current project in methods continue to limit flight simulation realism. Research is needed to develop a full-color, high-resolution laser projector-based flight simulator visual display.

PHASE I: Phase I will develop and produce a design for a laser projector-based flight simulator visual display.

PHASE II: Phase II will develop a system based on the design.

COMMERCIAL POTENTIAL: This technology could be used by the entertainment industry for highly realistic video arcade games or for highly realistic video shows that immerse the participants into the show. Alternatively, the technology could be used to present the high resolution images needed by medical personnel to view internal body parts/organs through remote sensing devices.

REFERENCES:
Peppler, P.W., and Gainer, J.C. (1993). A full-color, high-resolution laser projector for a flight simulator visual display. (AL/HR-TR-1993-0120, AD A270 578). Mesa, AZ: Armstrong Laboratory, Aircrew Training Research Division. Unclassified. Distribution Unlimited.

AF95-034 TITLE: Logistics and Information Technology for Weapon System Acquisition and Support

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop technology to improve system reliability, maintainability, supportability, and deployability while decreasing the costs.

DESCRIPTION: Research is needed to develop and refine techniques for the creation and presentation of technical information for use by maintenance personnel. The Department of Defense is rapidly moving toward implementation of electronic technical manuals to support aircraft maintenance. Although the basic technology exists, there are many research opportunities to develop improved and more cost effective techniques for creating and presenting technical information. Research areas include: techniques for presenting complex graphical information on small computer screens; methods to simplify human/computer interface for use with small, special-purpose computers with limited user input capabilities; methods for presenting technical information in an easily-understood manner; techniques to automate the conversion of existing paper-based technical data into the required electronic format, and techniques for creation of maintenance of technical data directly from engineering and logistic support analysis data.

PHASE I: Phase I will result in the identification, preliminary tryout and documentation of candidate technologies.

PHASE II: Phase II will result in fully-tested technologies and software (where appropriate).

COMMERCIAL POTENTIAL: The technologies have many potential applications including the development/authoring of automated technical manuals and training materials, the development of automated information systems for maintenance of complex equipment (such as commercial aircraft maintenance, automotive maintenance, and nuclear power plants maintenance), and development of automated computer based training systems. The technologies are applicable to any system which requires the presentation fo complex technical information on computer systems.

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Link, W.R., Von Holle, J.C., and Mason, D. "Integrated Maintenance Information (IMIS): A Maintenance Information Delivery Concept." AFHRL Report No. TR-87-27, Air Force Human Resources Laboratory, Brooks Air Force Base, Texas, November 1987. AD-A189 335. Unclassified. Distribution Unlimited.

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AF95-035 TITLE: <u>Manpower Acquisition and Assignment Technology</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Increase trainability and adaptability of military personnel while maintaining or reducing costs.

DESCRIPTION: Detailed narrative descriptions are in technical information packets available through DTIC.

a. Research is needed for computer-based assessment of response styles to measure factors such as susceptibility to distraction and decrements in performance under time stress and increased response demands.

PHASE I: Phase I will result in design specifications of proposed tests and software documented in a technical report.

PHASE II: Phase II will result in a validated battery of tests and inventories suitable for administration on the current Basic Attributes Test.

b. Research is needed for techniques for psychomotor skill assessment.

PHASE I: Phase I will result in recommendations regarding the composition of the test battery and hardware.

PHASE II: Phase II will result in a computer-based test battery that has undergone initial administration, reliability analysis and factor analysis.

c. Research is needed to develop non-invasive measures of neural conductive velocity as a culture-free method of cognitive assessment.

PHASE I: Phase I will result in a detailed technical report on the development of a computer-based system for measuring speed of neural impulses in the optic nerve.

PHASE II: Phase II will result in validated self-contained computer-based device that can be used in operational selection programs.

COMMERCIAL POTENTIAL: Technologies developed would have general utility to any large organization in areas of personnel selection, job analysis and career management.

REFERENCES:

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AF95-036 TITLE: Automated Instructional Environments

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Design Automation

OBJECTIVE: Perform research for development and use of new and emerging interactive technologies in planning and implementing advanced learning environments.

DESCRIPTION:

a. Research is needed to develop empirically validated principles of instruction and intelligent performance support tools to guide the design and development of interactive, computer-aided multi-media instructional environments.

PHASE I: Phase I will result in concept papers and proof-of-concept instructional environment prototypes.

PHASE II: Phase II will result in fully functional prototypes with instructional implementations and evaluations in each of the areas of avionics training, complex decision making, problem-solving, and troubleshooting.

b. Research is needed to develop innovative methods to determine the efficiency and effectiveness of varied intelligent training systems and environments (i.e., DoD, academic, and industry) for trainees of different skills and abilities.

PHASE I: Phase I will outline the development of prototype data collection methods to assess variables and constructs related to assessing media and trainee attributes and developing indices of trainee skill acquisition, retention and decay, and training efficiency and effectiveness.

PHASE II: Phase II will involve test, refinement, and validation of the methods and indices. It will result in a report and the development of a computerized trainee assessment and training efficiency and effectiveness measurement system. Further, it will assess trainee skill acquisition, retention, and decay, for selected training programs and systems. Proposals should assume that the technology will run on an 80486, or better, environment.

c. Research is needed to transition of a diverse array of emerging learning domain knowledge from research laboratories into more applied settings. Current generation microprocessors offer powerful delivery platforms at reasonable expense. The challenge remains, to scale up from "toy" laboratory instructional domains to fully-developed real-world instructional domains.

PHASE I: Phase I will implement brief, proof-of-principle automated instructional systems in Air Force domains, based on instructional strategies validated through rigorous pedagogical research. These systems could include part-task trainers, intelligent tutor authoring systems, digital video interactive, hypermedia, and multimedia environments.

PHASE II: Phase II would expand this prototype to a full-scale instructional system, thus producing fully-realized automated curricula in instructional domains of interest to the Air Force but applicable to DoD, industry, and education.

d. Research is needed for instructional development/delivery technologies that maximize student involvement, increase learning, and decrease time-under-instruction, regardless of student/teacher location.

PHASE I: Phase I will result in technical specifications and proof-of-concept demonstrations concerning integration of Affected Domain into the Instructional Systems Development (ISD) process, voice recognition/synthesis in computer-based training and microprocessor-based multimedia distance learning.

PHASE II: Phase II will result in validated prototypes.

COMMERCIAL POTENTIAL: Recent trends in technology development have increased, rather than decreased, the complexity of operating and maintaining systems. The Department of Labor's Work Force 2000 studies have documented the increasing complexity trend where jobs of the 21st Century will require increasing scientific literacy or professional technical skills. At the same time the basic skills of those entering the work force are actually declining. Further, those entering the work force will have dynamic jobs which will keep them always in a training mode to stay abreast of changes in existing jobs or retraining into jobs created by new technologies. The result is that DoD, government, industry, public and private education, and academia must have new technologies to make the increasing education and training burden more effective and less costly. Increasing portions of government and industry budgets are going to training and there is a public outcry for education to reverse the falling test scores and provide students with fundamental skills necessary to be effective in today's world. America 2000 and similar academia initiatives are not showing the required improvements. Public and private markets abound for viable intelligent courseware development and delivery systems. Course authoring systems for developing affordable intelligent computer based instruction systems, interactive multimedia distance learning technology, and training utility assessment technologies which incorporate state-of-the-art outcomes of laboratory learning research have the customers waiting -- now we need the products to satisfy the need.

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AF95-037 TITLE: Development of High-brightness Vision Stimulator and Retina Tracking Device

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Develop high-brightness, high-fidelity visual stimulator or system to track retina during laser radiation.

DESCRIPTION: The DoD and industry are rapidly improving and creating technologies which will aid in the study of the eye. Research is required to understand and model the visual effects of laser radiation on the human eye under various conditions. New technologies may be applied to the development of two separate improved devices; a high-brightness, high-fidelity, vision stimulator and a retina tracking and stabilization device, to research the effects of laser radiation.

a. Because of the inability to do live-fire tests of lasers against personnel in the field, man-in-the-loop simulations of the effect of lasers in military operations is desired. Presently, indoor laboratory experiments are limited by the relatively low brightness and resolution of television and VGA images. Similarly, simulations have inherent limitations because of the display

devices. A visual display with brightness better than high-definition television (HDTV) and resolution and frame rate equal to or better than HDTV is required.

PHASE I: Phase I will result in the identification of candidate technologies and development of a preliminary design for a high- brightness, high-fidelity vision stimulator. Initially a monochrome display would be acceptable.

PHASE II: Phase II will result in formalization of the design and construction of a prototype vision stimulator.

b. Presently, research is ongoing at Armstrong Laboratory to determine minimum visible lesion thresholds which requires the accurate placement of laser radiation in a grid on the retina. Clinicians also need to accurately deliver laser radiation to precise retinal locations to treat retinal pathology. Currently researchers and clinicians deliver laser radiation to the retina by stabilizing the eye through anesthetization or requiring prolonged fixation by the subject. There is a need to accurately place laser radiation in a grid on the retina without excessive anesthetization or eye fatigue. Research is required to identify technologies which will allow the tracking of the retina with eye movements. The tracking should be updated at regular intervals so that a real-time position of a small area (nominally 100 micrometers diameter) of the retina can be tracked.

PHASE I: Phase I will result in the determination of feasibility, technical design and proof-of-concept for the retinal tracking device.

PHASE II: Phase II will develop an apparatus which would track a mammalian retina in real-time as the eye moves. This apparatus will be able to control connecting optical components which would aid in the delivery of visible radiation to the retina.

COMMERCIAL POTENTIAL: The vision stimulator could be the front end of Distributed Interactive Simulations (DIS) and flight simulators. It could also be used in research experiments on vision function. Other uses include high- definition TV, virtual reality, cockpit displays, commercial aviation, low vision aids, and computer terminals. The retina tracking and stabilization device could be used for thousands of clinical ophthalmic retinal laser treatments which are done annually by government and industry.

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AF95-038 TITLE: C4I Systems/Subsystems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop innovative concepts for improving or increasing the capability of Air Force command, control, communication, computer, and information systems or subsystems. (This topic is of special interest to Electronic Systems Center (ESC))

DESCRIPTION: Proposals may address any aspect of AF C4I systems not specifically covered by other SBIR topics. Areas of interest include, but are not limited to: C4I concepts for fixed and mobile command centers, tactical operations, and special forces operations; fusion of data from various sensors for AF ground-based and air-based surveillance and early warning systems; innovative approaches to beyond-line-of-sight communication; AF mobility issues; C4I technology for medical care in remote locations; innovative manufacturing capability for full-function flat panel display systems; lightweight materials, fabrication

processes, and protection measures for electronic equipment shelters; innovative methods for employing commercial communications technology; innovative approaches to modeling the cost of C4I system ownership, and to the reduction of life cycle cost; decision analysis tools for determining the optimum C4I system maintenance level. Proposal titles must reflect the specific C4I problem being addressed.

PHASE I: Provide a report describing the proposed concept in detail and showing its viability and feasibility.

PHASE II: Fabricate and demonstrate a prototype device or subsystem or software program.

COMMERCIAL POTENTIAL: All solutions proposed must have potential for use/application in the commercial as well as military sector, and potential commercial applications must be discussed in the proposal.

AF95-039 TITLE: Business Process Reengineering Tools

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop tools and methodologies to support process reengineering. (This topic is of special interest to Electronic Systems Center (ESC))

DESCRIPTION: The recent government interest in business process reengineering has prompted the need for appropriate tools in several areas. The DoD's Corporate Information Management initiative is the largest information management program ever conceived by any U.S. business organization. ESC, as the center for business reengineering, has a need for tools and methodologies to support their ongoing work as a pioneer in process reengineering. Areas of interest include IDEF 2-6, automating/facilitating "to be" workshops, advanced activity-based costing, complementary functional/economic analysis tools, process and data reengineering analysis, and tools and methodologies to facilitate movement of model information to simulation, and software design. Of special interest are tools capable of passing models and data to other reengineering tools.

PHASE I: Provide a report describing the proposed concept and its implementation, with appropriate analysis to demonstrate its feasibility.

PHASE II: Develop and demonstrate the prototype tool.

COMMERCIAL POTENTIAL: These tools and methodologies will have commercial application because of the current high level of interest in process reengineering both within the DoD and the private sector. Vice-President Gore is leading an effort to "Reengineer the Government", and COTS tools to automate this effort will find a market. Work performed in this topic will directly and simultaneously benefit both government and industry.

AF95-040 TITLE: Identification of Human Intruders

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop a procedure to identify human intruders in restricted areas. (This topic is of special interest to Electronic Systems Center (ESC))

DESCRIPTION: Physical security systems utilize response personnel to challenge human intruders in a protected area. Often, personnel who have tripped the alarm can only be classified as authorized or intruders by their location in restricted areas. There is no established means, other than by individual verbal challenge, to distinguish between authorized personnel and intruders. A light-weight, low-cost, ruggedized, reprogrammable device is required to provide positive identification of authorized personnel. The device must operate in the mid- and long-wavelength infrared spectral bans, and must be effective out to 1000 meters.

PHASE I: Develop an innovative approach to identifying authorized personnel in restricted areas surveyed by thermal imaging sensors. Provide a report showing the feasibility of the proposed concept and a preliminary design.

PHASE II: Design and fabricate 25 fieldable prototype units for evaluation under a multi-environment joint test program conducted by the government.

COMMERCIAL POTENTIAL: The device would be useful in commercial security systems protecting high-value installations such as airports, refineries, and power plants.

AF95-041 TITLE: Multiband Radio Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: To develop and demonstrate radio technology which supports wireless connectivity wide area information networks. (This topic is of interest to Rome Laboratory (RL) and Electronic Systems Center (ESC). Identify whether proposal is for RL or ESC evaluation).

DESCRIPTION: The US Air Force has a global communications requirement to enable rapid application of air combat power via assured connectivity with timely, reliable, responsive, yet affordable, dissemination of information from HQ's down to the lowest, mobile, tactical force elements. The AF needs innovative research to enhance our ability to transfer large amounts of data, quickly, accurately, and securely. Researchers must identify promising wireless technologies which will provide substantial immunity to hostile action (electronic warfare), maintain connectivity in the face of battle damage (link outages), meet requirements for high performance in capacity and timeliness, be user-friendly, and enable transparent connection and interoperation with other services and friendly forces. Specific task areas for innovative research include methods and techniques that: a) enhance throughput, streamline interfaces to wide area information assets and advance radio architectures, and increase modularity, programmability, security (including LPI/D and AJ techniques), commonality and compatibility throughout various military and civil services and across the frequency spectrum; b) pursue data compression/decompression solutions that allow information to be transmitted at lower bandwidth and then reconstructed at the destination. Some data compression standards exist (JPEG and MPEG), but these do not necessarily satisfy high end users who wish to exchange massive amounts of data in real time without noticeable degradation. Techniques are desired that provide better compression/decompression than offered by JPEG and MPEG. c) through signal detection, waveform recognition, parameter estimation, passive surveillance and interference excision, enable radios to sense and dynamically adapt to the signal environment to optimize performance; d) enable radio operators, via flexible, user-friendly man machine interfaces, to quickly and efficiently manipulate functions within integrated communications assets, with minimal errors and training. Virtual control panels or pull-down menu trees are avenues for consideration and comparison. e) provide efficient means to model communications technologies as above as custom software module(s) for the Signal Processing Worksystem (SPW); f) provide means, using SPW models, to demonstrate the effects of radio channel effects on data compression technologies such as image and speech processing.

PHASE I: Identify techniques, explore algorithms, design interfaces, analyze and define designs for task areas a-f above. Provide comparison and simulation support for design decisions and detail trade-offs. Supply test and analysis data.

PHASE II: Develop and demonstrate improvements attained through the application of Phase I concepts, techniques, and designs. Develop and demonstrate prototype systems/subsystems.

COMMERCIAL POTENTIAL: The commercial sector is urgently in need of secure, reliable communications which are free of benign interference and noise. Advanced communications techniques such as spread spectrum, interference excision, waveform recognition, etc., perform as well to counter noise, interference, spectral congestion, and other civil communications difficulties. Innovations in digital data compression, multi-band antennas and couplers, wideband transceivers, and MMI techniques are also transferable to the commercial user. Conversely, commercial communications means will be exploited extensively for military use. Programmable and flexible interfaces between military radio equipment and commercial networks will enlarge dual-use potential.

AF95-042 TITLE: Innovative C3I Technologies

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop innovative technologies for enhancing the performance, availability and affordability of C3I systems and subsystems.

DESCRIPTION: Proposals may address any aspect of C3I pervasive technologies not specifically covered by other SBIR topics. Areas of interest include, but are not limited to, innovative concepts and technologies in: signal image and speech processing, computer science, including software engineering, computer systems technology and artificial intelligence, electromagnetic technology, including phased array antennas, null steering and scattering, superconductive electronics and EM materials and components, photonics, including optical memory, processing, devices and materials, and reliability and diagnostic technology. This topic offers great flexibility for proposers to offer innovative technologies with revolutionary impact on C3I systems and subsystems.

PHASE I: Provide a report describing the proposed concept in detail and show its viability and feasibility.

PHASE II: Fabricate and demonstrate a prototype device or subsystem or software program.

COMMERCIAL POTENTIAL: The C3I technologies all have substantial dual use potential and will impact competitiveness and performance of the commercial sector as well as the military sector.

AF95-043 TITLE: Low Insertion Loss Microwave Optical Source

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop high efficiency 1.3 um wavelength microwave modulated semiconductor laser with transistor driver.

DESCRIPTION: Power link budget is a critical issue in all microwave fiber optic links. Presently available fiber optic links are limited by very high link loss which limits their performance in applications including antenna remoting and optical control of phased array antennas. These links have been excluded from several military and commercial applications because of high link loss. The major contributions to this loss at microwave frequencies are poor laser electrical-to-optical conversion and impedance mismatch at the signal input to the laser diode. Since laser manufacturers have concentrated on developing high speed lasers without regard to the conversion efficiency, new laser structures designed for high efficiency will be required. The second major loss contribution is the impedance mismatch at the signal input to the laser. In order to match the 50 ohm impedance line to the laser which has a low impedance, typically a few ohms, a large series resistor is usually connected to the laser. Consequently the microwave power delivered to the laser is a small fraction of the drive power resulting in a power loss of 10 to 15dB. An integrated transistor driver will provide gain and will match the 50 ohm line to the impedance of the laser. The goal of this program is to substantially reduce the insertion loss of wide bandwidth microwave fiber optic links. Collaborations are encouraged.

PHASE I: Experimentally demonstrate feasibility.

PHASE II: Develop 20 GHz broad band fiber optic links with an insertion loss improvement of at least 20dB over presently available links.

COMMERCIAL POTENTIAL: Microwave designers have avoided using fiber optic systems in many military and commercial wideband microwave applications because of high link loss. The development of an impedance matching transistor driver and a high conversion efficiency laser diode will significantly improve the link loss and permit the use of fiber optic systems in these applications. Military and commercial applications include antenna remoting, phased array radar, and analog and digital communications systems.

AF95-044 TITLE: Multifunction Phased Arrays

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop affordable phased array antenna technology for future vehicles.

DESCRIPTION: Military, commercial, and private air, ground and sea vehicles of the future will require sophisticated but affordable antennas. Diverse requirements exist in areas such as video, voice, data and fax links, GPS connectivity, surveillance and collision avoidance radar, package tracking, emergency communications, and multi-gigabit per second digital connections. Expected performance will vary from high gain, multi-element arrays to low gain, multiple function single elements. Sensor systems will operate in multiple bands within the full microwave spectrum. Digital beamforming, adaptive control and neural

networks will lead to more flexible and cheaper sensors for commercial and military systems. These new capabilities include: smart control for array antennas that can sense failures and correct or compensate antenna patterns, super-resolution and neural network techniques that can perform accurate direction finding with smaller systems using less accurate, lower cost components, automatic system calibration based upon the use of available beacons, and adaptive cancellation of interference for mobile satellite terminals. These capabilities allow the use of small, low cost radar and communication sensors with increased capability due to the flexibility of adaptive digital smart control. Since most of this flexibility will be implemented by and under computer control, the development of low-cost, digital beamformer modules containing all components from radiating element to A/D converter is key to this initiative. Parallel processing architectures are needed that compete in price and performance with Butler matrices and Rotman lens for programmable, multibeam systems. The emerging technology of direct digital synthesizers based on fast D/A converters will drive digital beamforming on transmit. The goal is an all digital, neural controlled phased array made affordable by multilayer packaging, reduced cost per function and efficient predictive codes that work to -60dB.

PHASE I: The contract should target a specific antenna application, refine the concept by a thorough theoretical analysis, trade study and error analysis, and perform preliminary experiments on key subsystems that will test the overall idea.

PHASE II: The contract should demonstrate the full r-f performance expected by a prototype operating in a realistic environment, and deliver a component, subsystem, or full system implementation so as to attract Phase III venture capital with a working prototype.

COMMERCIAL POTENTIAL: An expanding commercial use of high technology products will include radar and communication capabilities for a variety of portable and mobile systems. Included are mobile links to Global Positioning Satellites, manpack and vehicle mounted satellite links, collision and high data rate links for voice, video, data and fax. These systems will face increasing demands for improved performance while maintaining pressure to continually lower cost.

AF95-045 TITLE: Group IV Photoemissive Layer Fabrication for High Reliability Infrared Sensors

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Demonstrate an ultra-high vacuum growth system that is suitable for creating infrared detectors from elements in Group IV of the periodic table.

DESCRIPTION: Platinum Silicide (PtSi) is the primary material used for photoemissive infrared detectors. PtSi has been shown to have exceptional properties for imaging in the 3.0 to 5.0 micrometer infrared spectrum. Modern AF systems also require sensitivity in the 8.0 to 12.0 micrometer spectral region. PtSi is unable to fulfill this need and other material systems must be used. Recent work using alloys of silicon and germanium have shown interesting possibilities for infrared sensing. The use of these materials on a silicon substrate shows promise of creating an infrared detector having 8.0 to 12.0 micrometer sensitivity while being affordable and producible. The Group IV materials for infrared detection must be fabricated in an ultra-high vacuum environment. The growth chamber must be designed to have low levels of both carbon and oxygen which have been shown to have deleterious effects on infrared diode performance in PtSi detectors. In addition to infrared detectors, there is a growing need for silicon germanium alloys in transistors and integrated circuits. This tool will be competitive in that market should it become commercialized.

PHASE I: The program will consist of an ultra-high-vacuum growth chamber for silicon-germanium alloys. The ultimate vacuum must be of the order of 10E-10 to 10E-11 Torr, and the chamber must be instrumented to show chemical species in the growth environment.

PHASE II: The program will result in the construction of a system based on the Phase I design. The system will be demonstrated by the contractor and delivered to for final test and layer growth.

COMMERCIAL POTENTIAL: There are many uses of this heat sensitive technology. Power companies could use PtSi cameras to examine the insulators on power transmission lines to see if they are defective and leaking power away from the lines. This will cause heating of the insulator and eventual failure. Fire fighters would find these new, inexpensive infrared sensors important for looking through smoke to see the places in a fire where the heat is being generated. In addition, forest fire fighters would be able to see the hot spots on a fire. Printed circuit manufacturers could run their boards under operating conditions to see if components were too hot and would fail prematurely. Medical applications include sensing of spot heat sources such as infection or tumors in soft tissue.

AF95-046 TITLE: Optically Controlled Smart Spatial Light Modulator

CATEGORY: Basic Research
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: To develop a multiple level (either phase or amplitude) Spatial Light Modulator (SLM) with integrated lens arrays and multiple pixels capable of being used in a coherent system.

DESCRIPTION: Proposals should address the following issues : Ability to realize multiple levels (at least eight levels), ability to preserve the phase of the readout beam, and ability to realize multiple local functions via optical input. Proposals will be evaluated on the extent that they meet each of these requirements. Most of the current optically flat (lambda/10), high contrast (100:1) Spatial Light Modulators are limited to binary outputs and rudimentary functionality on a pixel by pixel basis. Although useful for signal processing devices (e.g. correlators) they have overall limited performance due to the restriction in dynamic range. The addition of multiple levels significantly improves the performance when the signals are embedded in clutter noise. In addition, recent research has shown enhancement can also be achieved using relatively simple local operators such as 1/f filtering in the Fourier plane or 2-d image demultiplexing. The simplest approach to providing both local functionality and multiple levels is to fabricate super pixels containing both gray level modulators (i.e. polarization rotation) and simple circuitry with photodetector control. To separate input, readout and control beams, lenslet arrays can be used. However, commercially available lenslet arrays do not preserve wavefront flatness. The first objective is therefore to design a modulator that has the ability of generating multiple levels, either phase or amplitude (minimum of 8 levels). The second objective, is to design a method for optically addressing each pixel with multiple signal and control beams. For example, an improved lens array could be integrated onto the device or a holographic correction plate could be applied to an existing commercial array or a flip chip technique could be used with modulators on the back side. Such an integrated opto-electronic focal plane processing chip would significantly advance the state of the art in optical processing (correlators) and also optical computing and can be realized by combining existing technologies, specifically, OASLM's, VLSI and microlens array technology.

PHASE I: Demonstrate the feasibility of the idea by fabricating at least 1, multi-level device (minimum eight levels). Phase front flatness in the all-on state must be lambda/2 (both rms and over the entire field) on the readout beam. Each pixel must have a minimum of 4 detectors per pixel with some functionality such as multiplication integrated on chip. Pixel sizes can be as large as 200 microns and the lenslet array need not be integrated onto the actual device.

PHASE II: A full scale 256 x 256 chip with integrated lens arrays would be constructed. Pixel sizes in this phase should be in the 30-50 um range and phase front flatness in the all on state should be lambda/5 (both rms and flatness) over the entire array.

COMMERCIAL POTENTIAL: The Optically controlled smart spatial light modulator will consist of a pixelated reflector array controlled by a detector array. For this reason, it has potential dual-use in the areas of flat-panel displays and camera technology. With minor modifications this device could be used either to display binary information or act directly as a camera. In addition, the crystal technology integrated with the lens array technology specified in this SBIR will allow the device to be lightweight and have a high fill-factor which may find use in helmet mounted, heads-up or virtual reality displays.

AF95-047 TITLE: CAD Models for Millimeterwave Monolithic Antenna Components and Ultra-wideband Technology for Antennas and Communications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Improved components for low cost millimeterwave phased arrays and ultra-wideband technology for surveillance and communications.

DESCRIPTION: Monolithic millimeterwave components such as low noise amplifiers (LNAs), power amplifiers and phase shifters are needed for wireless local-area networks, automotive radars, millimeterwave satellite links and phased array antennas. Improved computer aided design (CAD) models for indium phosphide high electron mobility transistors (InP HEMTs) would lead to better component performance and lower design costs. Improved models are needed most for InP HEMTs materials optimized for power applications. Since InP HEMTs are generally measured and used in packages or enclosures it is also very important to be able to model the coupling or interaction between these two elements. The goal is to reduce modeling error

functions by at least a factor of two through physical insight. This effort would require excellent knowledge of semiconductor physics and electromagnetics and would utilize Rome Laboratory in-house InP HEMT experimental measurements.

PHASE I: Demonstrate feasibility of the modeling concepts.

PHASE II: Formulate and refine models for incorporation into commercial CAD software.

COMMERCIAL POTENTIAL: Both military and commercial communications and radar systems need to handle huge amounts of information rapidly. The wideband systems required are often limited because a lack of certain critical components creates performance bottlenecks. Identifying and circumventing these key problem components through novel or advanced technological solutions provides a good opportunity to enhance systems performance. Effective exploitation of the terahertz bandwidth of the fiber optic "Information Super Highway" requires truly wideband electronic and electronic/optical interface components. New devices with large fractional bandwidths need to be invented. Also, high resolution radars require wideband radiating and receiving systems. Wideband pulsed radars usually use two antennas to provide the required isolation to protect the receiver from transmitter power. A high-isolation wideband duplexer is needed to allow use of a single shared antenna. Current and proposed secure spread-spectrum type communications networks, both military and civilian, will also benefit from wider bandwidth components. Some ultra-wideband source signals and fast optical switch resources located at government facilities may be available for this work.

AF95-048 TITLE: Single crystal Substrate for Wide Bandgap Semiconductor III-V Nitrides

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop growth process for production of substrates which are lattice matched and thermally compatible with wide bandgap III-V Nitrides

DESCRIPTION: There is currently an increased interest in the III-V nitrides for potential laser applications in the blue and ultraviolet wavelengths. GaN, AlN, and InN form a continuous alloy system which can emit optical radiation spanning the range of wavelengths from the red to the ultraviolet. One of the major obstacles to research on III-V Nitrides is the lack of a suitable single crystal substrate material that is lattice matched and thermally compatible with GaN. At present GaN, AlN, and InN are grown primarily on sapphire or silicon wafers because of their commercial availability, but SiC, GaP, GaAs, ZnO, and MgO are also prospective candidates for use. All of these materials have drawbacks for growth of epitaxial layers of III-V Nitrides. The problem is that the atomic spacing of the substrate must equal that of GaN for lattice matching. Furthermore, the substrate crystal structure must be cubic to provide a template for growth of cubic GaN. Finally, the coefficients of thermal expansion of substrate and epilayer must be equal in order to avoid dislocations and stress-cracking upon cool-down. Since none of the available substrates meet these criteria, this effort will be focused on developing suitable substrate materials including bulk GaN, InN, or AlN. Novel approaches to producing bulk substrates will be considered. Crystal growth and characterization will be required in order to verify that the proposed approach will meet the above criteria.

PHASE I: Investigate possible approaches, selecting one or more candidate approaches. Design and build a system for growth of bulk substrate material.

PHASE II: Using selected approach, demonstrate crystal growth and characterization of bulk substrate material, and carry out tests to determine suitability for growth of III-V Nitride epitaxial layers.

COMMERCIAL POTENTIAL: Wide bandgap semiconductor materials exemplify dual use because the same technology used to fabricate solid state blue lasers can be commercialized for high density data communication and storage such as CD-ROM's.

AF95-049 TITLE: Polylithic OEIC Assembly Technology

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Optoelectronic integrated circuit technology base for high performance, reduced cost, integrated III-V and group IV circuits for telecommunications and target acquisition.

DESCRIPTION: Performance requirements for Opto-electronic integrated circuits are continuously elevated by system requirements. The potential of light-wave speed and ultra high bandwidth have driven the scientific community to research and develop a host of discrete optical and electronic components that appear to meet the high performance system challenge. In particular, discrete GaAs and InP optoelectronic devices have shown dramatic improvements, yet, little has been accomplished regarding integration of these components into fully functional O-E circuits that can be utilized by circuit designers. For example, high performance discretes are often fabricated using sophisticated epitaxial growth techniques. Often, however, the layer structure and growth methodology for different components are mutually exclusive or result in non planar surfaces which leads to tedious processing and low yield with expensive manufacturing prospects not to mention poor performance. This and other process issues preclude the fabrication of high complexity OEICs. The full potential of photonic communication and target acquisition cannot be reached until a technology base uniquely targeted at the OEIC integration challenge is established. Given the overwhelming complexity of full monolithic circuit O-E integration, it is reasonable to explore component and sub-circuit assembly using state-of-the-art hybrid assembly methods. Since sub components can consist of dissimilar materials, this assembly is referred to as polylithic (in contrast to monolithic) integration. Polylithic assemblies allow circuit design based on component characteristics independent of semiconductor materials. The goal of this effort is the development of a family of manufacturable assembly technologies for assembly of polylithic integrated opto-electronic circuits consisting of subsystem components from the GaAs, InP and/or Silicon families. Assembly can involve a number of methods including combinations of metal-metal bonding, semiconductor-semiconductor fusion, patterned substrates, conventional lithography or other yet to be invented techniques. Interactive collaborations are encouraged.

PHASE I: Experimentally demonstrate feasibility of assembly method.

PHASE II: Demonstrate integration technique on functional high bandwidth integrated optical receiver or transmitter circuit operating in the 1.3-1.6 micron range.

COMMERCIAL POTENTIAL: The development of this technology will provide a universal process base which will allow fabrication of both commercial and military opto-electronic integrated circuits for digital as well as analog applications. Presently, there are no standardized processes for III-V integration of opto-electronic monolithic or polylithic circuits.

AF95-050 TITLE: Photonic Interconnects for Processors & Optical Memory

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop Advanced Photonic Interconnects For Improved AF Digital Signal Processing Computers & Optical Memory Subsystems.DESCRIPTION: Ultra-high throughput optical or hybrid opto-electronic digital signal processing and high capacity memory capability is required for global surveillance and command & control/intelligence functions in future AF systems. Subsystem development efforts, in the general area of optical interconnects, are desired to provide near-term application-oriented technology solutions. Photonics Center and Rome Laboratory resources, including state-of-the-art optics laboratories, devices, and photonic test instrumentation, as well as device fabrication foundry services are available as GFP for such subsystem demonstrations. Proposed efforts should be designed to ultimately address a specific AF processing problem. Specific areas of interest are: Applications-oriented development of surface-relief diffractive optics for broadcast and N-to-N general interconnects, and fixed & reconfigurable 2-D polymer waveguide clock distribution and 3-D free-space gate-level interconnects; Multichip-module chip-to-chip interconnects, and wafer-scale/board-to-board interconnects; Integrated optical crossbar switches and optoelectronic packet switching subsystems specifically for multiprocessor interconnects; and applications-oriented development of optical memory addressing & I/O schemes including interconnects, SHG read-out, EO dynamic focus lensing, coherent laser array addressing, utilizing Rome Laboratory developed memory media.

PHASE I: Demonstrate feasibility of the interconnect concept, and develop a demonstration plan for phase II.

PHASE II: Should involve a full-up and well defined collaborative multichannel electronic computer or 3-D optical memory interconnect demonstration, performing an interconnect function relevant to a well defined signal processing problem.

COMMERCIAL POTENTIAL: Use of DoD-developed optical interconnect and memory technology will result in commercialization of these photonic concepts due to the enormous computational and storage advantages provided over all-electronic technologies. This is particularly important in such applications as modeling and simulation, virtual reality supercomputing, data/knowledge-base computing, and fast, low-power signal processors.

AF95-051 TITLE: Signal Processing for Information Enhancement

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Development of recognition capabilities for military law enforcement and environmental agencies.

DESCRIPTION: Development and application of signal processing algorithms for enhancing the information obtained from wide area surveillance sensors. A problem arises when one attempts to assess a given scene. Environmental noise sources compounded by system imperfections deny the agency clear identification of objects within a scene. Examples of such problems include poor focus, blurring, low signal to noise ratio, and temperature. We are seeking signal processing algorithms and architectures which sharpen scene features by deblurring and fusing of all the information from sample to sample. Samples may include frames, spectral components, pixels, and statistical segmentation. The end product should make an automatic identification of the subject within the scene.

PHASE I: Develop the innovative concept for information enhancement processing in sufficient detail for a feasibility determination to be made, perform analytical evaluation of the concept, and perform a simplified simulation analysis of the concept.

PHASE II: Implement the innovative concept for information enhancement processing. Perform detailed analysis of its overall performance capabilities and of its performance with respect to the most applicable mission for the concept. The heart of these analyses should be a live experiment. Also, perform an analysis to determine failure modes as well as to determine other, less critical weaknesses.

COMMERCIAL POTENTIAL: This technology has commercialization potential in the detection and identification of criminal as well as environmental assessment activities. Examples are enhancement of features from camcorder images, remote sensing of terrain and subterrain properties.

AF95-052 TITLE: Thin Film Semiconductor Photorefractive Devices

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop thin film semiconductor photorefractive devices for two dimensional, real time optical signal processing applications.

DESCRIPTION: Thin film photorefractive devices are promising candidates for 2-dimensional optical processing. The lack of high quality devices has limited the use of such devices. Recent development of semiconductor Multiple Quantum Wells (MQW) has enhanced the prospects of utilization in both military and commercial applications. Current MQW devices utilizing the quantum confined Stark effect (perpendicular geometry) exhibit high speed, moderate diffraction efficiency, and limited spatial resolution. Proposals are requested which address these limitations. Specific goals include a device operating at 830- 850 nm wavelength, with speed less than 5 ms at 1mW per sq. cm., diffraction efficiency greater than 5%, and spatial resolution less than 5 micron.

PHASE I: Demonstrate the feasibility of approach by fabricating and testing sample devices which have high sensitivity and good spatial resolution. These devices shall be delivered to Rome Laboratory at the end of Phase I.

PHASE II: Photorefractive devices will be optimized and fabricated for commercial availability. Products utilizing these devices will be developed.

COMMERCIAL POTENTIAL: These devices have much potential with applications including target recognition, robotics, sorting, finger print and figure identification. Fabrication using standard semiconductor processing technology offers reproducibility and manufacturability.

AF95-053 TITLE: Smart Pixel Signal Processors

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop Advanced Hybrid Photonic-Electronic Smart-Pixel Processor Technology For Improved AF Digital Signal Processing & Computing Systems.

DESCRIPTION: Ultra-high throughput optical or hybrid opto-electronic digital signal processing and computing capability via the use of smart-pixel interconnects is required for global surveillance and command & control/intelligence functions in future AF systems. Subsystem development efforts, in the general area of opto-electronic processors, are desired to provide near-term application-oriented technology solutions. Photonics Center and Rome Laboratory resources, including state-of-the-art optics laboratories, devices, and photonic test instrumentation, as well as device fabrication foundry services are available as GFP for such subsystem demonstrations. All efforts should be designed to ultimately address a specific AF processing problem. Specific areas of interest are: Applications-oriented development of massively parallel monolithic opto-electronic hybrid smart pixels & circuits; Hybrid ultra-high speed massively parallel digital processors, and digital neural net processors; In-plane waveguides; Integrated FETs and optics; SEED-type modulators and also VCSEL technology; and GaAs and InP, and silicon-hybrid technology.

PHASE I: Demonstrate feasibility of the smart pixel concept and develop a demonstration plan for Phase II.

PHASE II: Should involve the development of a full-up and well defined collaborative signal processing demonstration prototype, operating with throughputs greater than 1 GOps.

COMMERCIAL POTENTIAL: Significant commercialization of this DoD-developed smart pixel technology is assured due to the enormous computational advantage over all-electronic technologies, especially in the areas of digital neural-net processors for pattern identification and speech recognition, and low-power light-weight digital signal processors for avionics and space-based applications.

AF95-054 TITLE: Multisensor Fusion Processing

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop innovative concepts in multisensor fusion processing for improved target detection and tracking.

DESCRIPTION: The concept of multisensor fusion has long held intuitive appeal as a method of providing improved detection and tracking capabilities. However, achieving the promise of fusion has been a slow, deliberate process. Typical existing surveillance sensor systems rely on an individual sensor. There are limits to how much the performance of a surveillance sensor can be improved. Multisensor fusion can potentially improve performance beyond these limits, while much theoretical work has been done, there has been only limited work done on developing applications. Further research in both areas is needed. An innovative concept should be stated in a way that makes it clear whether the focus of the concept is: (1) More in the improvement of theoretical capabilities of fusion algorithms, or (2) More in the application of innovative fusion concepts to missions of interest. An innovative concept should show promise of producing a performance improvement over current state-of-the-art. Improved detection and tracking performance through the innovative fusion concept as reflected in improved receiver operating characteristics and/or improved tracker operating characteristics are examples of desired performance enhancements. Areas of interest include pre-detection fusion, detection to track fusion, and track to track fusion.

PHASE I: Develop an innovative concept for multisensor fusion processing in sufficient detail for a feasibility determination to be made, perform an analytical evaluation of the concept, and perform a simplified simulation analysis of the concept.

PHASE II: Implement the innovative concept for multisensor fusion processing. Perform detailed analyses of its overall performance capabilities and of its performance with respect to the most applicable mission for the concept. At the heart of these analyses should be either a live experiment or a detailed simulation. Perform an analysis to determine failure modes as well as to determine other, less critical weaknesses.

COMMERCIAL POTENTIAL: This technology has commercialization potential in any area in which the requirement exists for the detection of sensitive phenomena that stress the capabilities of an individual sensor. Examples are areas such as manufacturing, medical technology, and improved air traffic control capability. There is also a potential remote sensing application that could contribute to the detection and analysis of areas with environmental quality problems.

AF95-055 TITLE: Artificial Intelligence/Expert System (AI/ES) Pre-Processor for Computational Electromagnetics (CEM)

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop AI/ES tool for defining and developing input for CEM analysis and simulation codes.

DESCRIPTION: Air Force missions require the assured performance of advanced system technologies in severe electromagnetic (EM) environments. The application of CEM simulation early in the life cycle of new or modified systems is essential in assessing the operational performance of systems in electromagnetically rich environments. This helps ensure operability prior to full scale development, thereby reducing the cost associated with extensive redesign and retrofit. However, as with most CEM tools a great deal of expertise and time is required to define the approach and develop the geometric and electromagnetic models of the system. An innovative application of AI/ES technology would be as a pre-processing aid to CEM tools. An interactive AI/ES CEM front-end would aid both the expert and the novice in developing the CEM input file to ensure appropriate, accurate and timely simulations within the constraints of the CEM tool. Among the duties of the AI/ES pre-processor would be, for a user defined analysis scenario, to determine the most appropriate of available solution techniques, define the most accurate and efficient approach to the simulation, convert CAD system model, if available, into valid EM structure model or validate user created model and, finally, store as syntactically correct input for the CEM tool.

PHASE I: Define the general software design of the AI/ES pre-processor, develop basic rule base and demonstrate concept and functionality using the Air Force developed CEM tool called the General Electromagnetic Model for the Analysis of Complex Systems (GEMACS).

PHASE II: Produce a fully functional Beta version of the AI/ES pre-processor for a number of popular CEM codes that employ various EM solution methods.

COMMERCIAL POTENTIAL: This AI/ES CEM technology is also essential to the commercial sector which includes the airline, automotive, medical and consumer electronics industries.

AF95-056 TITLE: Opto-Electronic Packaging and Fabrication for Reliability

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop new packaging and fabrication methods to assure device performance during rapidly changing environmental conditions.

DESCRIPTION: Opto-Electronic devices are sensitive to rapidly changing environmental conditions such as temperature, vibration and moisture. Failure of the devices under adverse conditions often results from the movement of optical elements within the package. Creating rigid structures to hold the optical portions in, can cause excessive stress to build in the device which also may result in a failure. New packaging and fabrication methods are needed to address these problems.

PHASE I: Develop alternative solutions for the various environmental performance limiting factors.

PHASE II: Construct functional prototype for verification of fabrication approach.

COMMERCIAL POTENTIAL: Opto-Electronic devices have advanced to the point where they are being integrated into larger number of commercial and military systems. A great deal of work has been focused on the manufacturability of the optical portion of the devices. This program is designed to increase the reliability of the packaging and interconnects. Opto-Electronic devices are being touted as one of the technology answers for the information highway. Reducing the cost and increasing the reliability of the packaging will greatly aid this task and benefit a wide variety of users.

AF95-057 TITLE: Residual Stress Mapping Technique

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop marketable technique for routine measurement of residual stresses in microelectronic devices.

DESCRIPTION: The problem is that the reliability of microelectronic devices is dependent on the stability of the interconnect metallization. Microelectronic manufacturers have resorted to multi-layer metallizations to accommodate miniaturization and multi-level interconnect schemes. A natural result of this layering is an increase in residual stresses due to the processing of dissimilar materials at different temperatures. The technical challenge is to devise a dynamic system which can be easily used to measure residual stresses after processing and during testing. Present systems such as the rotating anode X-ray technique require special training and equipment not readily accessible to a process engineer. The accessibility of a simple tool would encourage more companies to evaluate product after deposition rather than at the end of the production cycle with the most value added. The desired results are a more reliable cost-effective microelectronic device.

PHASE I: Develop user friendly technique for routine mapping of residual stresses.

PHASE II: Manufacture and market tool for use by microelectronic firms to routinely monitor interconnect residual stresses.

COMMERCIAL POTENTIAL: A readily available technique for residual stress measurements is imperative to producing high quality reliable microelectronic devices for both commercial and military applications. Such a technique would allow in-process monitoring of metallizations for high stress development. In the best instance, wafers with stressed metallizations could be detected early enough in the process to permit reworking. The worse case scenario would be that no more value would be added to the wafers cutting losses by scrapping. The processed wafers would eliminate void nucleation and hillock problems exacerbated by high stress. Resultant reliable devices would be available for commercial (medical, transportation and communications) and military (transportation, communications, and weapons) applications.

AF95-058 TITLE: Mixed-Signal Simulation and Modeling Techniques

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop technology in support of mixed-signal modeling and simulation, based on the emerging IEEE VHDL-A standard.

DESCRIPTION: This topic area seeks to advance the state-of-the-art in mixed-signal modeling and simulation technology by providing research and development work to further the forthcoming IEEE analog extensions to VHDL. In general, support for design, diagnostics and test is lacking for complex and increasingly prevalent analog and mixed-signal electronic systems. This topic area addresses the support of simulation and test of mixed-signal electronics across the integrated circuit, board and system level, as well as validation of the forthcoming IEEE VHDL-A standard. Candidate topics which will be considered include, but are not limited to: analog extensions to WAVES (Waveform And Vector Exchange Specification IEEE STD 1029.1), development of VHDL-A syntax/semantic checkers, development of a prototype VHDL-A simulator, development of SPICE-like component libraries, Language validation, on-line hypertext User's Manual tools, etc. PHASE I: Efforts will research the proposed topic area arriving at a suitable solution(s) to the problem.

PHASE II: Efforts will develop tools and techniques to further the EDA technology base for analog/mixed-signal design and test.

COMMERCIAL POTENTIAL: A mature mixed-signal modeling and simulation technology will fill the void in existing approaches to design, diagnostics and test of analog and mixed-signal electronic systems. Tools in this area will provide a decrease in the development time as well as reduce overall system costs including those of initial system design, life cycle support and reprocurement for both commercial and military applications. This technology will have a major impact on applications for automobiles, communications, medical and aerospace systems.

AF95-059 TITLE: Circuit Synthesis for Power Optimization

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Research and develop IC power optimization methodologies and techniques and integrate them into a synthesis system.

DESCRIPTION: With the Air Force requirement that circuits be as small and low power as possible, and the recent increased commercial importance of portable electronics, there has been a change in design philosophy from managing the growth of power to reducing the overall power consumption for many systems. Also, with growing complexity and density of transistors on a chip, the natural trend is for power to increase. Many techniques and methodologies have been developed for analyzing and/or reducing the power dissipation of an integrated circuit (refs. 1-6). Unfortunately, these techniques and methodologies have not found widespread usage because of the lack of automated tools that employ them. Current synthesis tools that are used for today's integrated circuit designs may be used to optimize the design for either performance or area. But as circuits are optimized for performance and/or area, power dissipation for a densely packed or extremely high speed design has become a major concern and may limit the circuit's lifetime, reliability, maintainability, etc. A multi-objective optimization and synthesis capability that optimizes designs for power dissipation as well as area or performance, is needed in mainstream CAD tools. Synthesis tools need to expand their capabilities to include power dissipation optimization as well as performance and area optimization. The contractor should not limit itself to the circuit level. The techniques and methodologies should be evaluated to determine their applicability to higher levels of design hierarchy (i.e. Multi-Chip Modules, etc.). This effort will develop a prototype commercializable synthesis tool that will be available to the major CAD tool developers for integration into their circuit design frameworks.

PHASE I: This effort will research and develop methodologies and techniques for optimizing power dissipation in integrated circuits, investigate the feasibility of incorporating these methodologies into synthesis systems and develop the structure for a prototype synthesis tool.

PHASE II: This program will implement the techniques and methodologies from Phase I into a prototype commercializable multi-objective optimization integrated circuit synthesis tool which will have the capability to optimize a design for power as well as performance and area.

COMMERCIAL POTENTIAL: A multi-objective design optimization and synthesis capability would enable the trade-off of power, area and performance in high density microelectronic circuits. This has an impact on the development of portable electronics, a rapidly growing portion of the consumer electronics market. Automated techniques for optimization promote the rapid and low cost development of circuits, reduces the time-to-market, and increases the opportunity to get to market first, which is so critical in the ever changing electronics industry. The Semiconductor Industry Association has identified power and power management as a "show stopper" for the continued growth of the microelectronics industry. The automated optimization and synthesis of circuit designs for power, area and performance enables the development of light weight, high performance, low power electronics for military systems. This effort supports current DOD Dual-Use programs such as the Rapid Prototyping of Application Specific Signal Processors (RASSP) Program. This ARPA funded program focuses on US technology for the rapid development of advanced circuits.

AF95-060 TITLE: Large-Scale Computing System Failure Effects Analyzer

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop a software tool to assure extremely low failure probabilities in computing systems by injecting random errors.

DESCRIPTION: There are currently no simulation-based methods to assure extremely low probabilities of failure of large hardware/software computing systems. For example, the Fault-Tolerant Multiprocessor (FTMP) is designed to have a failure rate due to random causes on the order of 10**(-10) failures per hour. However, such a low failure rate cannot possibly be assured with existing fault simulation or fault injection tools. There is a need to research the feasibility of innovative algorithms that would allow years of simulated system operation to be done, so as to generate meaningful statistics for failure rate prediction.

PHASE I: Feasibility demonstration, showing approach for obtaining statistically-significant simulation data in affordable amount of real time and computer CPU time.

PHASE II: Prototype software tool(s) that satisfy the need given in the Description.

COMMERCIAL POTENTIAL: The proposed results have commercial applications in the design of large, distributed computing systems that affect public safety. Examples are air traffic control systems, railroad routing systems, systems, and flight-critical aircraft control functions. The products of this effort would be a set of tools that would permit the quantitative demonstration of extremely low failure rates. The proposed results would also be useful to the Department of Defense in the design of large C4I systems. In particular, these tools would be used in the design of distributed fault-tolerant computing systems.

AF95-061 TITLE: Event Representation For Advanced Techniques In Information Processing

CATEGORY: Basic Research
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop and implement an algorithm for representing real world events for advanced numeric processing techniques.

DESCRIPTION: For the past two years Rome Laboratory has been applying neural networks and other advanced processing techniques to the automated modeling of event scenarios. These models are used to predict up coming events based on events which have already occurred. This process is called situation assessment. Events in the scenarios (e.g., troop movement, communication activity, aircraft spottings, economic tensions) may be as detailed as information on actions of a single person, or as general as the activities of a national economy. Initial research indicates that current processing techniques can adequately model the temporal and spatial relationships required for situation assessment. However, there is currently no suitable method to represent event data as an input to advanced processing algorithms. This is the question of how to represent troop movement, aircraft spottings or economic tensions to a neural network, fuzzy logic system, or any other advanced processing system. Current operational systems still apply old template matching techniques which are brittle and do not take advantage of the characteristically 'fuzzy' representation of relationships in modern advanced processing techniques. The objective of this SBIR is to develop and implement an algorithm for representing real world events for use with advanced numeric processing techniques. This would allow the use of those processing techniques in the situation assessment of real world

PHASE I: Design algorithms for automated creation of event representations. Demonstrate their effectiveness in representing events from several domains. Demonstrate how they would be integrated into the intelligence process.

PHASE II: Develop software allowing easy manipulation of the algorithms developed in Phase I so they may be integrated into the intelligence process. This software will provide a simple graphical use interface for developing and integrating event presentations into new domains.

COMMERCIAL POTENTIAL: The objective of this SBIR is to develop and implement an algorithm for representing real world events for use with advanced numeric processing techniques. This would allow the use of those processing techniques in the situation assessment of real world events. The technology developed under this effort will provide capabilities applicable in the dual use arena. These applications include the representation of medical events for pattern recognition of symptoms in medical data, pattern recognition in law enforcement data, pattern recognition of financial trends in industry, as well as the analysis of patterns of activity in military intelligence data.

AF95-062 TITLE: Information Extraction From Text Through Application Of Advanced Processing Techniques

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computers

OBJECTIVE: Demonstrate the ability of advanced processing techniques to extract information from textual information.

DESCRIPTION: Rome Laboratory has been examining advanced processing techniques for the automated extraction of information from textual information. Such information is critical in performing event scenario modeling and situation assessment. Significant information is included within free text messages, which many times goes unexploited, or exploited only when an analyst has time to read such information. Current techniques for extracting information from text include simple pattern matching schemes and Natural Language Understanding (NLU) algorithms. These techniques may overlook significant information, and may not provide a full understanding of the text. Advanced processing techniques include neural networks, fuzzy logic systems and other advanced information processing algorithms. Capabilities of these techniques for pattern extraction and correlation make them ideal for this application. In addition, the extracted information could be used by advanced processing applications which perform situation assessment or event detection. Many of these applications use advanced processing

techniques, and the information would be represented in a format ideal for such applications. The objective of this SBIR is to demonstrate the extraction of information from text through the use of advanced processing techniques.

PHASE I: Explore, identify, and prototype/demonstrate promising automatic text extraction algorithms.

PHASE II: Select, refine, and test the most promising automatic text extraction algorithms using a large data set of free text messages. Integrate the best algorithms into the General Intelligence Processor architecture.

COMMERCIAL POTENTIAL: Automatic extraction of information from free text data will provide major benefits to any commercial entity which presently performs this task manually, or not at all. The task of manually extracting information from free text (e.g., newswire reports, free text messages, other correspondence) is manpower intensive, costly, and much information goes unnoticed. An automatic extraction capability using advanced processing techniques will have a major impact on the banking and financial world, news reporting, decision support systems, the insurance industry, law enforcement, and military intelligence.

AF95-063 TITLE: Hostile Target Identification

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors

OBJECTIVE: To develop technology for the identification of airborne targets through the exploitation of non-cooperative techniques.

DESCRIPTION: The Air Force must be able to positively identify hostile aircraft in combat and at long ranges in order to gain the maximum advantage of beyond-visual-range (BVR) weapons and ensure a first-shot, first-kill capability. Indirect non-cooperative target identification (NCTI) techniques ensure long range, high confidence identification that provide enhanced situational awareness information to command and control and fighter platforms for the control and execution of the air battle. This project develops and integrates the necessary suite of complimentary passive and active NCTI technologies for such command and control platforms as the airborne Warning and Control System (AWACS) as well as other national, theater and tactical collection elements.

PHASE I: Develop architecture and demonstrate concepts for enhanced radar identification of airborne targets.

PHASE II: Develop and deliver prototype for enhanced identification of airborne targets through Hostile Target Identification.

COMMERCIAL POTENTIAL: The two main technology thrusts in the Hostile Target Identification technical base includes multisensor fusion and advanced signal processing using neural nets, fractuals, wavelet transforms and the like. There is a significant commercial utility to both areas. The multisensor fusion technology has direct application to the medical arena in addressing multiple, advanced medical sensors such as those encountered in high technical operating rooms in hospitals. Fusion technology also has direct application to industrial processes using advanced robotics and advanced robot sensors. Fusion technology also has direct application to managing competitive business enterprises especially in the area of information fusion. The advanced signal processing technology can provide an improved technical baseline to commercial satellite sensors, robotic sensor processing and acoustic optical, infrared, and commercial radar sensors.

AF95-064 TITLE: High Performance Intelligent Information Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Investigate high performance computational mechanisms to develop tools/techniques that facilitate the evolution and integration of information sources and intelligent systems.

DESCRIPTION: Advanced computational models are being developed to process data at very high speeds (petaops) under initiatives in the Federal High Performance Computing and Communications Program. Ways to integrate (glue) the various forms of raw data, including restructuring, to discover knowledge using these new computational paradigms need to be investigated. Tools and techniques need to be developed to 1) enhance capabilities to "mix & match" pieces of functionality and diverse data types for knowledge discovery through assembly of software components and object knowledge-bases, 2) provide the ability to build store, share, reuse, and integrate massive intelligent data bases, 3) provide models of intelligent software behavioral and

architectural designs, using languages such as HPC++, 4) provide metrics and methodologies enabling measurement, comparison, and evaluation of competing intelligent information systems. Mechanisms to be investigated include associative techniques for incomplete data analysis, electro-optical techniques for storage and interconnection of objects, data flow mechanisms for multiple system interoperation, and rule/mediation for intelligent information analysis/dissemination.

PHASE I: Investigate development of tools/techniques to perform knowledge discovery in massive high performance intelligent systems.

PHASE II: Demonstrate unique intelligent system techniques using appropriate high performance computing platform(s) in both military and commercial domains.

COMMERCIAL POTENTIAL: The access to information stored in diverse locations is becoming increasingly critical to support planning and optimization efforts for a number of applications. Rapid accessibility to information increases choices for consumers in both civilian and defense applications. This technology could have major impact on applications that require timely and accurate information such as nuclear power plant control, autonomous vehicles, aircraft operation, hospital life support systems, decision support systems and military command and control.

AF95-065 TITLE: Low-Cost User Premises Equipment for Integrated Broadband Network Access

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Demonstrate a flexible user premises system that can be easily configured to provide access to a variety of broadband ISDN networks and services.

DESCRIPTION: The type of equipment necessary to connect users to the "information superhighway" will depend on the network and service interfaces and the attached user equipment. For example, users could connect to a network via a telephone line, a cellular telephone link, a CATV coax, a wireless CATV link, or various satellite options. Attached equipment includes various combinations of telephones, computers, and/or television/video systems. It is likely that service providers will supply proprietary turn-key user premises equipment to their subscribers. However, a standardized system that performs a set of basic universal access functions and allows the insertion of hardware and software modules to perform service-specific access functions can provide flexibility and possible cost reductions to users that do not want to be locked into a proprietary access system. With such a system, physical layer access hardware modules would be inserted into a standard open bus architecture and software supplied via a floppy disk or a smartcard would be installed to make the system comply with the desired service subscription agreement(s). Widespread availability would reduce acquisition, maintenance, and logistic costs and increase service flexibility for consumer, commercial, and military users.

PHASE I: Demonstrate the feasibility of implementing an open and modular B-ISDN user access equipment in a system design specification.

PHASE II: Produce a prototype implementation that would allow the concept to be demonstrated and explored in a laboratory environment.

COMMERCIAL POTENTIAL: If this concept proves to be technically and economically feasible, there is considerable potential for commercialization in the multi-media information services markets.

AF95-066 TITLE: Portable Node for a Distributed Computing Environment

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: To develop and demonstrate a portable node for a distributed computing environment.

DESCRIPTION: The next generation of information processing will be dominated by the use of very large clusters of computing elements integrated into a uniform computational environment to support collaborative computing. It will be characterized by a level of interoperability which masks the boundary between the individual machines and creates a single uniform computation space across all of the elements. One of the necessary components will be portable nodes which can be remotely connected to the system and become an integral part of the environment. This implies that the portable machine will host the necessary kernel

software for the distributed computing environment, and upon connection can be synchronized into the overall configuration. The objective of this SBIR effort would be to develop and demonstrate a portable node for a distributed computing environment. One of the available DCE's (BBN/CRONUS, OSF/DCE, etc.) can be used as the model environment. While the portable node may not support the same level of DCE functionality as a high performance workstation, it should provide the basic capabilities. One of the tasks would be to identify what the limitations are in terms of functional support.

PHASE I: Design and analysis to clearly describe the functionality level to be obtained with the portable node.

PHASE II: Prototype of the portable node capable of demonstrating the level of functionality incorporated in the design developed in Phase I.

COMMERCIAL POTENTIAL: Distributed Collaborative computing is one of the fastest growing segments of the commercial information processing industry. The advent of the laptop computers ushered in the practice of taking the computer with you as an adjunct to any business trip to allow you to more effectively gather and provide information. Coupled with explosion in availability of networking connectivity, these portable computers can now be linked back to the home office or to other colleagues in different locations. By fully developing the distributed computing systems software support on these portable computers, multiple people at different locations will be able to collaborate on the solution of complex problems even though they may be going from location to location. They will also have access to all of the information resources back in their main facility. It can change the way in which financial institutions, sales organizations, medical institutions and numerous others currently function.

AF95-067 TITLE: Collaborating Environment Technology

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop mechanisms to optimize higher level communications capabilities to transmit only pertinent information to be displayed in collaborative environments.

DESCRIPTION: Information from a variety of sources will be readily obtained, displayed and manipulated via multiple interface techniques ranging from hand gesture, eye tracking, voice, etc. They will greatly enhance nonlocalized multiple users' ability to access, change and reorganize displays that provide a large media display space which is context adjustable to immediate applications. To alleviate the contention on network resources, collaborating processes need to share information regarding their visualization contexts so that only the appropriate data needed for display within the current context/application will be transmitted. Appropriate information such as window sizes and number, viewing modes (2D/3D), centers of projection, clipping planes, etc. would be considered.

PHASE I: Assess strategies for negotiating various display formats/characteristics between nonlocalized collaborating environments.

PHASE II: Demonstrate a collaborative environment using the technologies designed in Phase I.

COMMERCIAL POTENTIAL: This technology is domain independent and will be equally applicable for distributed virtual and nonvirtual environments in the areas of medical, architectural, pharmaceutical, real estate, and CAD/CAM prototyping.

AF95-068 TITLE: System/Software Quality

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop advanced technologies to support software quality modeling, prediction, assessment, analysis, visualization, validation and improvement.

DESCRIPTION: The technical challenge is to address a multitude of problems inhibiting improvements in software quality. Advanced mathematical-statistical techniques for software quality factors/attributes models that are both available and needed should be addressed. Statistical methods should address tailoring problems associated with measuring and using software quality information. The use of visualization methods for predicting and assessing software quality is a key innovation area. General automation issues to deal with the high cost of manual data collection, integration of software quality methods and tool sets is

an area of weakness. Phenomenological/assessment models for determining achieved quality during operation and maintenance are needed to validate predictive models. Quality preserving technology is an uncharted area to be explored. Organizational models for quality and data based decision making (with a focus on using this information to adopt software engineering science and process improvement) do not exist. There is a need to combine product and process modeling. The cost of quality models and counting rules and procedures are needed to address issues such as the return on investment.

PHASE I: Demonstrate new high-payoff software quality models/metrics and process supporting technologies for factors and applications that heretofore have not been defined.

PHASE II: Produce advanced development prototypes and demonstrations of those prototypes using real-world scenarios of usage on realistically sized DoD and commercial problems. For new models/metrics their utility and validity should be demonstrated using either actual defense or commercial data.

COMMERCIAL POTENTIAL: The requirements for software model/metrics and supporting process technologies developed under this SBIR are shared by both the US defense and commercial industry. The level of rigor usually associated with defense application required is equally shared by the telecommunications, nuclear, and banking industries to name a few. The technologies developed for software quality should be application independent. Because the application area should drive the level of rigor needed, the technologies developed should address various levels of rigor.

AF95-069 TITLE: Advanced Visualization Techniques for Parallel Software Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop an advanced visualization system to assist programmers in developing parallel code.

DESCRIPTION: Recently a small number of visualization software tools have been developed to help programmers monitor the performance of their parallel code, or visualize the vast amounts of data computed as a result of parallel execution. But little attention has been given to the value of using these visualization techniques to assist programmers in actually developing this parallel code. For the sake of context, we define software development in this effort to be made up of a number of phases such as requirements analysis, specification, design, coding, testing and maintenance. Each of these phases to some extent could use visualization to help the software engineer make sense of the large quantities of data that are needed. The data may come in the form of textual data, graphs, lists of numbers, or design charts. The problem is compounded by the fact that this code is being developed for a parallel machine, which has software development problems above and beyond common sequential computing platforms resulting in even more development data. In order to make sense of the large amounts of data produced during development, what is needed is a tool or set of tools that can let the programmer see this data in new and innovative ways, therefore assisting the programmer in producing better parallel software.

PHASE I: The work to be accomplished in Phase I will focus on an approach to gather and present parallel software development data in an intuitive and cohesive fashion for parallel programmers.

PHASE II: Efforts undertaken in Phase II will concentrate on the development of this approach into a working prototype.

COMMERCIAL POTENTIAL: The underlying scope of the research to be performed in this endeavor is applicable to a wide range of high performance computing systems, and is very generic in nature. As such, it possesses significant application to the development of number of commercial computer and software systems in such arenas as the aerospace industry, the automotive industry, banking/finance fields, as well as medical related activities.

AF95-070 TITLE: Virtual Reality Lasercom Link

CATEGORY: Basic Research
DOD TECHNOLOGIES: Telecommunications

OBJECTIVE: Develop technology to provide wireless communications and position data for a virtual reality system.

DESCRIPTION: Two of the technical problems in developing virtual reality systems using Helmet Mounted Display (HMD) technology are the need for a high bandwidth communications link between the HMD and the processor, and the generation of

accurate multidimensional position information. Simply put, the computer that runs the virtual reality user display must get the data to the HMD and it must know the position of the user and the direction the user is looking. The typical way to communicate now is to connect the HMD with cables to the computers. This limits the movement and agility of the user. The position information is derived from a separate subsystem using magnetic or radio frequency position location systems. This adds complexity and weight to the HMD, further restricting movement. The purpose of this effort is to develop lasercom technology that will provide both communications and position information to the virtual reality system. The system must provide high data rate communications (e.g., a simple raw information rate might be calculated: 1024 x 1024 pixels x 24 bits/pixel x 30 frames/sec = 0.75 Gb/s) as well as position, velocity, and acceleration information in all directions. The system may be designed so that the active laser is mounted on or off the HMD. The requirements are that the equipment mounted on the HMD weighs less than 1 pound and allows freedom of movement within a 12' x 12' space. The transmitters must be in the power and wavelength range to be eye safe to the users.

PHASE I: System design and prototype fabrication and test of the critical components.

PHASE II: Fabrication and test of a prototype system with an actual virtual reality application.

COMMERCIAL POTENTIAL: Commercial applications for virtual reality are unlimited. The communications technology developed in this program supporting virtual reality would be applicable to a
wide range of commercial virtual reality applications. Commercial applications such as education, medicine, amusements, and architecture are also faced with the same communications and positioning problems that will be solved in this effort.

AF95-071 TITLE: Space Systems Technology Development

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Innovative developments for improving performance, endurance and survivability of future space and missile systems.

DESCRIPTION: Advanced space systems need a host of integrated technology developments in order to meet improved performance requirements. We are seeking innovative approaches and technology developments which will provide improved space system performance, endurance and survivability. The proposed approaches shall emphasize "dual-use technologies" that clearly offer private sector as well as military applications. Some examples of dual-use technologies include High Definition Television (HDTV), advanced Communications, Energy, and Environmental Conservation plus many more. Proposals emphasizing "Technology-Transfer" will receive additional consideration. Specific areas of interest include following:

Space Power Systems: Approaches leading to higher specific power at lower cost are needed. Specifically, long life, high energy density batteries, advanced solar cell designs, lightweight solar arrays, and power control electronics.

Thermal Management: Advanced spacecraft thermal control technologies, in all temperature regimes are sought. Technologies for improvement include (but are not limited to); heat pipes, micro-machined refrigerators and heat pumps, capillary pumped loops, integrated microelectronics cooling packages, thermal storage devices, deployable radiators, cryocoolers and cryogenic components.

Space Electronics: Innovative advanced processor, memories, and digital logic components; advanced micro-electronics packaging; micro-electromechanical systems and instruments; optoelectronic, photonic and analog processing electronics are sought, particularly those that lend themselves to operation in space environment. Candidate solutions must be radiation-tolerant or leverage commercial processes to exploit radiation resistance.

Space Systems Software: Advanced concepts in expert system design, fuzzy systems, distributed expert systems, object oriented database with expert systems, the integration of existing software (COTS and NDS) into an object oriented environment, and user interfaces.

Sensors: Innovations in developing ultraviolet to very long wavelength infrared detectors, readouts, focal planes and sensors. Innovative approaches in active sensor concepts including LIDAR, RADAR and associated signal processing, signal conditioning, including related devices and subsystems are needed.

Space Structures: Innovative minimum weight structural concepts are needed that can withstand high-G space launch and ambient environment effects. Active and passive vibration suppression, control, advanced material applications, design and analysis methods are needed.

PHASE I: Further develop the concept and perform analysis required to establish the feasibility of the proposed approach.

PHASE II: Complete the Phase I design and develop a demonstrator or prototype. Document the R&D and develop a technology transition and/or insertion plan for future systems and commercial ventures.

COMMERCIAL POTENTIAL: Space systems for DoD and commercial use require advanced technology that is highly reliable, high performance, and is survivable to a variety of man made and natural environments. These technologies have immediate and definite commercialization potential in consumer goods and infrastructure improvements such as highway safety, environmental monitoring, etc.

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AF95-072 TITLE: Small Innovative Energy Storage Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Energy Storage

OBJECTIVE: Develop small, innovative, high performance, low life cycle (including disposal) cost, long life energy storage systems with minimized environmental impact.

DESCRIPTION: The thrust is to develop a new, direct current (DC) battery for use in electronic hand-held portable radio and/or satellite secondary power applications. Ground troops and airmen require batteries that are easy to use, made from non-hazardous materials with low weight, high power density and long life at high depths of discharge. Satellites necessitate secondary batteries that offer high energy density (>100 Wh/kg), long cycle life (>1000 cycles) at high depths of discharge, long inactive shelf life, and reduced cost compared to state-of-the-art systems. The challenge for both applications is to combine these requirements, while keeping life cycle cost low. Batteries for the han-held radio can be either disposable or rapidly rechargeable, with minimized disposal cost.

PHASE I: In Phase I, the contractor shall produce the conceptual design of one or more energy storage systems.

PHASE II: In Phase II, the contractor shall develop a working prototype of the system as a proof-of-concept device. In addition, the contractor shall perform system analysis to determine the performance of their technology in comparison with state-of-the-art established energy storage systems.

COMMERCIAL POTENTIAL: The prototype could be further developed to meet the specifications of any electronic device that used an energy storage system.

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Bender,S.F., Biegger,D.W. "High Energy Density Zinc-Air Cells for Portable Electronics," in Wescon Conf Res 80, Sep 16-18, 1989, Anaheim, CA. 1980. 6p.

AF95-073 TITLE: Solid State Data Storage For Space Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a viable approach for creating reliable, robust, and compact data storage systems.

DESCRIPTION: The ability to store data for varying periods of time is a requirement for nearly every orbiting satellite. Large amounts of data have traditionally been stored with mechanically-based tape systems. Due to their mechanical nature, these systems are prone to breakage, represent single points of failure, and generate motion that must be compensated for. Unreliable storage on a satellite can, in many cases, render it useless, since the bulk of the data, gathered while the satellite is away from a telemetry reporting site, will be lost. Alternate storage systems, preferably without moving parts, are desired for future space systems. The realization of a solid state data storage system adequate for space use, however, is hindered by the lack of appropriate components, packaging, and architectures. Ideally, a storage system for space would have no moving parts, and, if degradation or failure modes existed, they would occur gradually. This feature would potentially eliminate the need for multiple units, typically needed for mechanically-based systems. Besides this economy of scale, the more versatile data handling flexibility inherent with solid state media allow revolutionary new and simpler data instrumentation schemes to be implemented in space systems. In order for solid state storage solutions to be effective, they must provide a core level of dependable storage for useful mission lifetimes of space systems. Robust recovery systems and creative exploitation of existing component technologies should not be overlooked in achieving a viable storage approach. Advanced packaging technologies, two and three dimensional, offer promising keys to creating a solid state storage system that is not only reliable, but perhaps more compact than contemporary mechanical and environmental specifications.

PHASE I: Phase I efforts must address efficient and reliable solid state data storage systems approaches, from architecture to the component. Unimaginative imitations of tape-based storage paradigms are discouraged, unless such implementations emulate existing standards, preferably with extensibility to more flexible storage approaches. Special emphasis on fault tolerance and deliberate consideration is required.

PHASE II: Execute an "existence proof" of the Phase I approach, with the goal of achieving as representative a space-qualifiable solid state storage system as possible. As a minimum, a brassboard must be constructed and characterized, both electrically and in radiation environments. The system, if not in final form, must be convincingly close to achieving this goal, with compelling evidence that such a system could indeed meet electrical, mechanical, and environmental specifications.

COMMERCIAL POTENTIAL: A large solid state storage market exists in nearly every segment of the commercial market, ranging from computer memory cards to high speed instruments, capable of capturing data at phenomenal rates. Space data storage systems can contribute to improving ther reliability and density of their commercial counterparts. In the commercial sector, competitive market pressures place more advance solid state storage concepts in an unfavorable position when compared to mechanical disk drives. In space, however, reliability is an important motivation, and the potential demand, though small compared to commercial markets, is enough to potentially drive the economics of scale for a new technology approach in the direction that can catalyze commercial interest, first in high-reliability, real-time applications; and later in more pervasive, lower cost systems.

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AF95-074 TITLE: Launch Vehicle Systems Technology

CATEGORY: Basic Research
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop conceptual space launch systems accompanied by "key" hardware demonstrations which validate technology risk, cost models, and performance.

DESCRIPTION: Due to increasing DOD cost and schedule delays associated with current space launch systems, new and creative approaches to space access is required. Improvements in cost and responsiveness (launch on need) are currently paramount to Air Force Space Command (AFSPACECOM). In addition, the overseas threat to our commercial space launch capability is seriously eroding the U.S.'s ability to compete internationally.

PHASE I: Address a comprehensive conceptual launch vehicle system: i.e. innovation in propulsion, structures, avionics, and operations concept. Vehicle systems that are enabling (critical in meeting advertised claims) will require at least one hardware test demonstration. The ability to build cost effective hardware that validates a critical conceptual launch system capability is a vital factor.

PHASE II: At a minimum, build, test and evaluate a major vehicle subsystem (subscale may be appropriate). The system chosen shall be the most challenging in terms of cost, technical risk (including manufacturing), performance and reliability. The ability to demonstrate advertised subsystem performance is critical.

COMMERCIAL POTENTIAL: USAF "technology transfer" for launch vehicles has virtually 100% application to private or commercial space launch systems. We are in the midst of a very unique time when foreign space launch capabilities are beginning to dominate the commercial market. Investment in launch vehicle technology is fundamental in securing a future for USAF and private sector space applications. The PL is chartered to advance space and space-related technologies and lowering the expense associated with space access is basic to that charter.

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AF95-075 TITLE: Innovative Cryogenic Cooler Concepts For USAF and Private Sector Utilization

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop cryogenic cooling, and/or associated technology improvements, which allow dual use for DoD and Air Force space-based optics/sensor crycooling with direct commercial cooler applications.

DESCRIPTION: The evolution of cryogenic cooling requirements necessitates reduced size, weight, and input power; longer life and increased reliability; and increasing net cooling load for these devices. Improvements in cryocooler design and efficiency for temperature regimes from 180K to less then 10K are highly desired. Proposers may submit new concepts for improvements in basic cryogenic cooler designs, associated component level improvements, increased reliability and maintainability, or other significant technologies which promote cryogenic cooling for the Air Force and private sector use. Prominent among the commercial applications envisioned for lightweight and reliable cryogenic cooling are communications, commercial satellites, computer and data systems, power applications, and medical instrumentation.

PHASE I: Develop initial designs and associated analysis to select the most promising approach. Preliminary demonstration of the chosen design is preferred but not required.

PHASE II: Further develop and demonstrate the preferred Phase I approach. Develop a plan for insertion of the Phase II demonstrated design into applicable Air Force and commercial systems.

COMMERCIAL POTENTIAL: Cryogenic cooler designs benefitting from improvements under this topic will be extremely useful for commercial applications. The cryogenic cooling potential applications include, but are not limited to, communications, commercial satellites, computer and data systems, power applications, and medical instrumentation. Cryogenic cooling applications for communications include improved Signal-to-Noise ratio, and/or cooled electronics for improved efficiency/reliability. Commercial satellite applications can range from optics/sensor improvements similar to Air Force uses to increased thermal management utilization. Computer and power applications benefits are similar to the communication applications described, with increased cost savings associated with improved efficiency and increased reliability. Medical uses of cryogenic cooling is widespread today (MRI, cryo-surgery), but use bulky and costly stored cryogenic fluids which could be replaced by cryogenic coolers.

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AF95-076 TITLE: Advanced Vibration Isolation System For Precision Manufacturing Tools

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Industrial Production

OBJECTIVE: Develop a hybrid passive/active system for vibration isolation and suppression in microelectronic manufacturing tools.

DESCRIPTION: Progress in large-scale integrated circuits has always been tied to the minimum feature size that could be produced on a chip (line width) and to the accuracy with which such features could be inspected. As feature size decreases to 0.5 micron and below, vibration in the tool induced by floor motion and other ambient factor becomes a limitation. Eventually, it could prevent the most advanced tools from being used in older plants. While active isolation and vibration suppression systems have been demonstrated, they are notoriously sensitive to dynamics of the payload. In simple terms, the stiffer the passive isolation system (higher suspension frequency), the more loop gain is needed in the active system to counteract the forces transmitted through the passive mounts, and the more likely the active loop is to be unstable. What is needed is a passive system

capable of suspension frequencies on the order of O.1-0.2 Hz, rather than those currently in use that give 2.0-4.0 Hz. Besides an immediate, large improvement in passive isolation, such a system would provide a much more hospitable platform on which to implement active vibration suppression.

PHASE I: Demonstrate in hardware the device-level basis for a passive isolation system with suspension frequencies below 0.2 Hz and suitable for chip manufacturing and inspection tools.

PHASE II: Develop and demonstrate a 6 degrees-of-freedom isolation system based on the very low frequency passive system and incorporating sensors, actuators, and controllers for active suppression of residual vibration.

COMMERCIAL POTENTIAL: Vibration immunity of chip production tools becomes critical when advanced submicron tools must be used in older plants, which may provide a poor environment with respect to ambient vibration and noise. Advanced tool-level isolation and suppression could help to maintain the competitiveness of existing plants.

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AF95-077 TITLE: Spaceborne Field Programmable Gate Array (FPGA) Integrated Circuits

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Provide rapid-prototyping for an almost arbitrary variety of digital electronics for space through space-suitable FPGA components.

DESCRIPTION: Within the last decade, the emergence of the FPGA has provided digital systems developers within industry and the military the capability to create complex digital systems in a fraction of the time and non-recurring expense of other approaches. The niche of the FPGA, by virtue of its flexibility, has expanded into a multi-hundred million dollar market, with applications ranging from computer workstations to missile systems. Only the space system designer is currently denied the rapid and versatile development capabilities that FPGAs offer. Furthermore, with the spartan selection of components available for designing and building space systems, no other application sector needs the flexibility more urgently. The space-qualified FPGA fills the significant gap in digital components that are already under development for space environments, such as the microprocessor and static random access memories (RAMs).

PHASE I: Develop a creative solution to the space qualified FPGA deficiency. Avenues available for exploitation are: process design/enhancement, layout technique, circuit design, etc. Hardening to total ionizing dose and immunity from single event upset and latch-up phenomena must be addressed in any prospective space-qualified FPGA. RAM-based FPGAs offer considerable flexibility and multiple design iterations, while one-time programmable (OTP) FPGAs have the potential advantage of long-term stability. In the event that RAM-based FPGAs can be demonstrated, it is desirable to minimize the dynamic configuration / re-configuration time, to make their application more attractive to real-time systems with circumvention architectures.

PHASE II: Demonstrate the FPGA approach defined in Phase I, complete with paths to adequate design/verification environments. An FPGA application demonstration system and electrical/environment characterization are highly desired and would validate the utility of the approach.

COMMERCIAL POTENTIAL: Space-suitable FPGAs have tremendous potential in leveraging the significant commercial infrastructure of the current commercial FPGA. Approaches must exploit existing electronic design automation (EDA) tools and preferably have functional compatibility with one of the currently popular FPGA families. Bare die availability and package compatibility with existing and emerging popular styles must also be addressed.

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AF95-078 TITLE: Smart Mechanisms

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop smart mechanisms to replace motor actuated components.

DESCRIPTION: A broad spectrum of motor actuated components are used in space and commercial applications. Recent advances in shape memory alloys such as nitinol and terfinol have made this technology available for use in smart mechanisms that replace pyrotechnic and motor-actuated devices. Development of nitinol release devices to replace pyrotechnics have been under development for several years. Nitinol is now being considered for a large number of motor-actuated deployment arms, gimbals, latching and positioning mechanisms, etc. Nitinol works by applying heat to expand the metal so that it takes a new form. When it cools, it returns to its original form. Nitinol mechanisms are extremely simple to build and operate and have dramatic advantages over motor-actuated devices. Reliability is much greater since there are no internal moving parts. Several alternatives to shape memory alloy devices for replacing motors include electrostrictive and magnetostrictive devices. All non-motor device technologies are to be considered in the design of the smart mechanisms.

PHASE I: Investigate candidate spacecraft and commercial components to be replaced by smart mechanisms. Identify components with the highest pay-off potential using smart mechanism alternatives based on reduced cost, weight, power and on improved performance and reliability. Develop smart mechanism(s) design and demonstrate feasibility of the unit(s).

PHASE II: Complete unit development and fabricate the smart mechanism(s). Demonstrate performance pay-off of the unit(s) based on test data.

COMMERCIAL POTENTIAL: A vast array of industrial, automotive, and aircraft actuating components are motorized and can be replaced by smart mechanisms that are much easier to fabricate and that achieve far greater reliability than motors. These units can also provide dramatic reductions in cost, weight, and power.

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AF95-079 TITLE: Innovative Small Satellite Thermal Control Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Energy Storage

OBJECTIVE: Develop innovative, low cost, reliable, low mass, long life thermal control systems for small space power (500 watts) satellites.

DESCRIPTION: The emergence of micro/nano engineering technology and the resultant potential reduction in the satellite systems presents both advantages and challenges in the field of thermal control. Advantages include large reductions in waste heat from some satellite components and smaller satellite dimensions which make it easier to isothermalize the vehicle and thereby simplify the thermal design and analysis process. Challenges may develop, however, in removing waste heat from densely packaged high power devices such as monolithic microwave integrated circuits. Miniaturization of active and passive cooling technologies, as well as, micromachining technology itself offer some potential solutions to thermal issues which may arise on these satellites. Technologies enabling spacecraft size, weight and power reductions while maintaining or improving performance are sought. Technologies for improvement include, but are not limited to: micro heat pipes, micro capillary pumped loops, integrated micro pump/micro heat exchanger cooling system, thermal storage devices, small deployable radiators, packaging techniques for multichip modules, and micro machined refrigerators and heat pumps.

PHASE I: Define and demonstrate the usefulness of practical techniques to improve particular aspects of thermal control systems, including issues of design, fabrication or operation. Formulate a development and test plan for integrating the component into prototype thermal control system. Practical technology insertion must be addressed, particularly noting the space environment requirements of prospective applications. Potential system cost reduction and commercialization must also be defined.

PHASE II: Develop a working prototype of the system (possible subscale) as a proof-of-principle device. Determine the performance of the technology in comparison with established thermal control systems.

COMMERCIAL POTENTIAL: Further develop the prototype to meet the specifications for a particular application as to power, mass, volume, temperatures, efficiency, cost and producibility. Potential applications of this thermal control system and associated technologies can readily be found in the growing commercial satellite market, as well as the obvious military and NASA uses. Considering the general trend toward the smaller satellite, the potential market for a successful small satellite thermal control systems and associated technologies is large.

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AF95-080 TITLE: Two-Dimensional, Narrow-Bandwidth, Multispectral Focal Plan Array

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop innovative, multispectral focal plan array for small satellites.

DESCRIPTION: Small, cheap satellites afford a potential solution to a number of critical military and environmental problems. These include wide-area surveillance, target detection and tracking, and attack warning, as well as the monitoring of weather, pollution, chemical plant effluents, and climate change. Precise spectroscopy in the long infrared wavelengths requires extreme cooling and large space platforms. More modest spectroscopy in the medium to medium long infrared wavelengths, however, may prove adequate for some missions. The challenge here is to demonstrate a multispectral focal plane array with narrow bandwidths which could provide an alternative to precision spectroscopy and thus would enable a number of essential missions to be accomplished with small, cheap satellites.

PHASE I: Develop the conceptual design for an innovative, multispectral focal plane array and an analysis which elucidates projected device operational requirements and performance.

PHASE II: Develop and demonstrate a prototype array. In addition, the contractor will analyze prototype device performance and compare with potential mission requirements.

COMMERCIAL POTENTIAL: The prototype would be tailored for specific DoD, civilian, and commercial applications. Civilian and commercial uses include: monitoring weather patterns, global pollution, ozone reactions in the upper atmosphere, chemical effluents from industrial plants, and climate change.

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AF95-081 TITLE: Adaptive Passive Vibration-Suppression For Space Structures and Sensors

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and demonstrate tuned passive vibration suppression devices that are adaptively tuned.

DESCRIPTION: Vibration suppression is important for many current and future space missions, during both launch and operation. Tuned passive dampers are an efficient means of providing high damping over a narrow frequency band. However, the dynamics of systems such as boosters and satellites change as fuel is consumed, and the dynamics of solar arrays change due to orientation or time in orbit. Vibration suppression solutions involving tuned passive dampers are of limited use in these cases because of their inability to adapt or re-tune to changing disturbances or structural characteristics over time. Recently, active means of vibration suppression have received a great deal of attention. However, active approaches require continuous power and have the potential of instability if the plant dynamics or controller properties change significantly. An active enhancement for tuned passive capability in the presence of time-varydampers would make those devices extremely effective by ensuring efficient use of the damping capability in the presence of time-varying dynamics. The passive components act as a reliable, built-in capability that relieves system power requirements without reducing the flexibility of a purely active system. The tuning strategy should require significantly less power than active control.

PHASE I: Investigate adaptive/passive vibration suppression concepts and compare with active control and conventional passive dumping techniques. The comparison should include power requirements, controller designs, and performance. Select a concept, develop a control strategy, and demonstrate the feasibility of the adaptive strategy using laboratory instruments.

PHASE II: Develop adaptive/passive devices and demonstrate on a testbed structure that has varying dynamics.

COMMERCIAL POTENTIAL: Tuned passive dampers are one of the most weight-effective passive damping devices, but mis-tuning has prevented many military and commercial applications. An adaptive/passive device will eliminate this concern. Also a self-tuning, robust, passive tuned damper will find many uses where a harsh or remote environment discourages manual retuning or minimal power is available. Potential applications include not only spacecraft, but also aircraft, TV and power transmission towers, rotating machinery, ground transportation vehicles, helicopters, truss structures, and optical telescopes.

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AF95-082 TITLE: Innovative Auxiliary Electric Power Supply

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion

OBJECTIVE: Develop innovative, low cost, reliable, low mass, long life auxiliary electric-power supply.

DESCRIPTION: The Auxiliary Electric Power Supply (AEPS) addresses three separate, but related USAF needs. First, by providing an AEPS that can use waste heat from boilers, stoves, water heaters, and furnaces to generate electric power, both to run those devices and to provide electric service independent of the grid, the USAF can significantly reduce operating costs. Second, an AEPS can provide cathodic protection of piping buried in soils, using either waste heat (from a hot pipe) or bleed fuel (from a fuel pipeline or storage tank) to reduce corrosion. Third, an AEPS could provide an economical means to dispose of waste oils, by using them as fuel for external combustion heat source; savings would result from the electricity generated and the elimination waste oil disposal costs. The technical challenge, is to design and build an AEPS that combines flexibility to fit different use environments, reliability, and durability to support remote site operations and reduce manpower costs, and manufacturability with acceptable development risk, life cycle cost, and program schedule.

PHASE I: Produce conceptual designs of one or more AEPS, identify their thermodynamic characteristics, materials of construction, interface requirements, development status, and life limiting mechanisms, and produce a development plan which addresses key technology issues.

PHASE II: Develop a working prototype of the AEPS. Also develop models to analyze the performance, cost and lifetime of the AEPS.

COMMERCIAL POTENTIAL: Every home in the USA with a gas powered furnace and/or water heater could use an AEPS similar to that developed under this program. Another significant market is in use as a mobile home/RV AEPS, run off either the exhaust heat or from bleed fuel. The commercial markets for cathodic protection of pipelines and utilization of waste oils dwarf the comparable government markets.

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AF95-083 TITLE: 50 MB, 10 GB Modem

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop high-speed low-power, bandwidth efficient modems.

DESCRIPTION: Due to the continuous increase in data transfer volume, there is an implicit need for higher data rate devices. This increased demand is seen in both the commercial industry and the military. Modulation techniques used in today's equipment are not very bandwidth/power efficient. The challenge to the innovator is to achieve high throughput at nominal frequencies and power consumption.

PHASE I: Develop a computer model that simulates the conceptual design characteristics of the proposed electronic device. In addition, the engineering techniques used should be shown to be feasible.

PHASE II: Design and produce the Application Specific Integrated Circuits (ASIC's) necessary to build a working prototype of the modem. Also, demonstrate that the design can be extended from the prototype data rate to 10 GB.

COMMERCIAL POTENTIAL: Because of the need to move large amounts of data, a 10 GB modem has great potential in the commercial sector. For instance, the amounts of data produced in the digitization of video is significant, and a 10 GB modem would enable the transfer of high resolution real-time digital video. This technology would also have application in Asynchronous Transfer Mode (ATM) networks where the target throughput standard is approximately 10 GB. Another potential application is in the development of future generation satellite systems that need to be lightweight while providing increased throughput.

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AF95-084 TITLE: Enhancing Satellite Operations Through Increased Space Automation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop and demonstrate innovative software method to increase space automation thereby enhancing satellite ground operations.

DESCRIPTION: USAF satellite ground operations are both labor intensive and costly. In addition, the training time required to bring an operator up to the appropriate skill level is lengthy. An increased number of Air Force satellites are scheduled to go on orbit in the coming years while at the same time downsizing will result in fewer operators being available to operate these satellites. A number of efforts are underway to increase automation of AF satellite operations from the ground perspective. The goal of this topic is to develop and demonstrate innovative software methods to increase automation of satellites from a space perspective thereby enhancing ground operations. Emphasis is placed on how automation can be moved from the ground to space. The challenge for the innovator is to be able to increase automation of satellites that are currently on orbit.

PHASE I: In Phase I, the contractor will provide a detailed description and design of the proposed method for enhancing satellite operations from the space perspective. Details will include particular satellite subsystems to be enhanced, satellite programs to be utilized, proposed hardware and software development platforms, software development methodologies, as well as any necessary ground interaction with the automated space segment. Details should also be provided as to the proposed method for integrating the developed software into existing satellite systems.

PHASE II: Develop a working prototype of the system and implement a proof-of-concept demonstration. Additionally, perform system analysis to determine the performance benefits of the technology when utilized with automated ground systems, cost, time, and manpower savings shall be quantified.

COMMERCIAL POTENTIAL: Increased automation of satellites and reduction of operations and maintenance costs is of interest to virtually every organization that operates satellites. Potential applications include Navy, NASA, and commercial satellites. In addition, there is potential for use of the technology in other space missions such as future NASA shuttle flights.

REFERENCES:

Anderson, C. PHILLIPS LABORATORY SOFTWARE CONSIDERATIONS, ADA & ADA9X. May 4, 94. Contact Phillips Laboratory/VTC, 3550 Aberdeen SE, Kirtland AFB, NM 87117-5776, tele# 505-846-0817 for copies.

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AF95-085 TITLE: Radiation-Tolerant Microelectronic Device Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop novel techniques to produce radiation-tolerant microelectronic devices for space applications.

DESCRIPTION: Most contemporary microelectronic devices used in USAF space systems are obtained from radiation hardened fabrication facilities. The technologies employed in fabricating these devices were developed to protect microelectronics exposed to nuclear weapons environments and exceed the requirements for many space applications. The cost of such devices are extraordinary and dramatically increase the cost of space assets that use them. Although the optimum cost and performance can be obtained by using commercially available devices, those devices typically degrade rapidly in the space radiation environment. The Phase I effort will focus on identifying novel design approaches and/or fabrication techniques that will yield radiation-tolerant (i.e., operate at developer-defined specification after 200 - 500 krad (Si) total ionizing dose) microelectronic

devices at reduced costs. Approaches that appreciably reduce the cost of microelectronic devices designed to survive in space radiation environments will be seriously considered. Some possible topic areas are: modified commercial fabrication processes, novel design and layout approaches, redesign of commercial devices, radiation shielding, or a combination of any of these.

PHASE I: Identify and develop novel design and/or fabrication techniques that yield radiation tolerant microelectronic devices at reduced cost.

PHASE II: Focus on demonstrating that selected approaches yield devices that are producible and that meet the Phase I specifications.

COMMERCIAL POTENTIAL: Every government and commercial organization that systems in space will benefit from the cost reductions that will be obtained in this effort. Furthermore, future microelectronic devices (i.e., those with very small feature size) operating on the earth will be susceptible to single event upset (this has been observed in the most advanced technologies available today). Therefore, the techniques developed in this effort that will avoid single event phenomena will benefit the entire microelectronics industry and its consumers.

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AF95-086 TITLE: Terabyte Communications

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Telecommunications

OBJECTIVE: Develop techniques capable of supporting terabyte data communications.

DESCRIPTION: With the advent of Asynchronous Transfer Mode (ATM) gigabyte data communication is within reach. The challenge for the innovator is to develop methods to extend data rates even further. The next logical step is to develop terabyte (10-12) data communications techniques. It was not long ago that 640 kilobytes of memory in a computer was deemed more than enough main memory for any application. However, today 16 megabytes is the minimum necessary to support a stable-multitasking operating system. As with these preceding digital systems, the trend towards higher resolution video with true 16 bit stereo sound continues to stress the data capabilities of today's as well as tomorrow's data communication rates.

PHASE I: It is expected that, in Phase I, the contractor will develop a computer model that simulates the conceptual characteristics of the proposed innovative technique. In addition, the engineering methods used should be shown to be feasible.

PHASE II: Build a system which used the techniques to achieve the stated objective.

COMMERCIAL POTENTIAL: Although ATM provides for gigabyte data rates, it is not difficult to see that in a short time even gigabyte communications will not be adequate to transfer the amounts of data being produced. There is a push in the civilian sector to produce High Definition Television (HDTV) on demand. A system such as this would have to be able to transfer enormous amounts of digital data to multiple subscribers continuously. A technology which makes terabyte communications possible would make this system possible. In terms of military applications, data rates of these speeds would make possible the real-time transmission of imagery data to multiple users for use in critical decision making. In short, terabyte communications systems are a key technology in realizing the so-called data "superhighway".

AF95-087 TITLE: Known-Good Die for High Reliability, Low Cost Space Electronics

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Improve complex hybrid microcircuits yield and lower system level costs through technologies which establish integrated circuits functionality before packaging.

DESCRIPTION: To reduce size, weight, and power, space systems are beginning to consider advanced packaging technologies, such as the multi-chip module (MCM), which combines a collection of off-the-shelf integrated circuits (ICs) in a single dense assembly. Unfortunately, because the quality of IC die are typically unknown until high-speed burn-in testing can be performed, the reliability and yield of MCMs can be dismal. Low yields lead to great expense, since more units are required to achieve a necessary quantity of working assemblies. If, for example, a method could be established to achieve much greater confidence in the quality of a part before it is committed to an assembly, the yield and reliability of MCMs would be dramatically enhanced. These technologies, referred to as "known good die" (KGD) technologies, do not currently exist in a practical form, but are desperately needed for nearly all electronic applications that can take advantage of MCM technology. Particularly for space, KGD technologies can potentially reduce cost in MCMs by replacing many individual qualifications for single components with one comprehensive qualification of a MCM assembly. This potential cost reduction can be substantial in space systems requiring many MCMs to meet functional requirements.

PHASE I: Pursue the fixturing and test methodology issues of the KGD problem. Wafer-level methods offer hope for low cost, mass production, but die-level approaches will also be needed, especially in near-term applications. In either case, it will be important to establish criteria or methodologies for achieving the highest possible confidence levels in the at-speed, in-environment functionality of individual components over the anticipated space-system mission life. Also address economics of scale, both in terms of the technology and in qualification of fewer components.

PHASE II: Demonstrate the fixturing and test methodology of the Phase I approach. Inasmuch as possible, "real" (as in existing) integrated should be involved in the demonstration. Economically it is feasible to consider lower-cost, commercial assemblies. However, the approach must be convincingly extensible to space-qualified microcircuit technologies.

COMMERCIAL POTENTIAL: KGD technology services the advanced microelectronics packaging industry, which is predicted to become a multi-billion dollar market by 1997. Since technologies capable of constructing non-trivial multi-chip modules have existed, the "known-food-die" problem is considered the most pervasive problem affecting the acceptance of MCM technology. The economics of space electronics differs from that of commercial electronics only in degree. Quantities are more modest and price is typically higher, due to qualification requirements. Accordingly, it is suggested that space electronics, due to higher reliability requirements, may be the most challenging proving ground for initially expensive KGD technologies, paving the way for commercial acceptance of KGD and MCM technologies.

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Cogleton, H., Root, R.E. "TRB TM Assembly-a Soft-Tooled Approach to Device Pre-Test and Interconnection," pp.183-185.

AF95-088 TITLE: Generic Inter-Module High-Count I/O Interconnects

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop high-count I/O connectors that can be placed at locations between multiple adjacent layers of multi-chip modules/high density interconnect (MCM/HDI) in three dimensional configurations

DESCRIPTION: As electronic circuits become more complex and physical component size becomes smaller, the number of I/O for each module layer becomes very large. Consequently the number of I/O in between each layer is rapidly becoming constrictive. If the I/O that is inter-layer remains trapped at the side of the module layer, there is a limit to the number of I/O and it also becomes restrictive to the signal distribution on each layer. If a set of devices can be developed to allow I/O to be placed any place on the set of modules to provide signal paths between two or three of the adjacent layers it will greatly increase the possible number of I/O, improve the speed of the devices by reducing signal-line length, ease the signal path distribution limitations, reduce the cost of device development. The components should be developed such that all signal paths are internal to the module after the plug has been integrated into the module and provide at least 200 I/O per sq-cm. The ability to extract and input the signals from and to the 3-D module should exist.

PHASE I: Develop the conceptual design of the inter-module I/O plugs and demonstrate the thermal transfer characteristics, the ability to subdue the signal noise, the ability to provide hermeticity and physical integrity to be approved for use in class S devices.

PHASE II: Develop a working prototype and demonstrate the use with a three dimensional MCM/HDI module of at least 3 layers. Provide analysis of the proof-of-principle 3-D module and prove the usability and versatility of the device developed.

COMMERCIAL POTENTIAL: The devices will provide manufacturers the ability to provide smaller, faster, lighter, less costly electronic components to the DOD and the public sector. The applications are virtually limitless: communications, radar, computer systems, etc.

REFERENCES:
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AF95-089 TITLE: High Power RF Sources, RF Effects Measurements and Satellite Protection

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop high power RF sources, components, measurement techniques, and produce new methods for addressing threat phenomena to satellites.

DESCRIPTION: The Phillips Laboratory is in need of new and innovative approaches in the development and demonstration of compact, light weight, microwave sources for both weapons and commercial applications. The technology sought should address sources capable of delivery gigawatt levels of power in microsecond or shorter pulses. Both narrow-band and wide-band sources are of interest. The technologies that may be addressed in this effort include pulsed power, high power microwave tubes, transmission lines, converters, and antennas. Also of interest are methods and techniques for measuring the performance of these components, the effects that such environments will have on electronic systems, and methods of protecting systems form electromagnetic environments over a wide range of frequencies and field levels. Protection agianst electromagentic effects with the increased use of electronics, lower power semiconductors with reduced noise, immunity thresholds, reduces sheilding through increased use of plastics and composite materials, and increased RF emissions will be critical for both military and commercial systems of the future. The increased use of Commercial-Of-The-Shelf (COTS) equipment in military systems will also require improved protection approaches for future systems. In satellites, additional protection is needed for other threat environments such as radiation, thruster firings, space debris, orbit dependent chemical reactions with naturally occurring species, and solar or laser radiation. Many of these environments are natural or occur during normal operations, but others may be threats faced by satellites during a war time situation. Reliance on commercial satellites for future military functions is likely to increase and reliable, survivable satellites are a must for both peace time and possible ware time conditions. Additional technologies of interest include high energy plasma production, measurement, and applications.

PHASE I: In the initial phase of this effort, feasibility experiments and demonstrations will be conducted to identify the best approach from those chosen to solve the problem. A proposed schedule for implementing the chosen approach, specific commercial applications, and possible market partners will be included in the final report.

PHASE II: In Phase II, the selected approach determined in Phase I will be developed and implemented, producing a prototype model, device, and/or process which has been demonstrated to be effective either at full operation, or scaled to laboratory bench parameters. Prototypes developed during Phase II will be delivered to the government in operating order with sufficient documentation to allow for validation testing.

COMMERCIAL POTENTIAL: Many of the necessary technologies required for military weapons and systems have commercial applications. The high power sources and antennas can be used to locate and identify buried unexploded ordinance needed in base clean up efforts. Other technologies associated with ultra wide band sources can be used to improve airport and other security systems operating at lower power levels commensurate with personnel safety. Protection of future electronic systems is a must in a society with ever increasing dependency on reliable operation of automobiles with airbags, anti-skid brakes, electronic transmissions and steering, fly-by-wire aircraft, information highway systems, and home appliances to mention a few. Increased use and dependency on satellites for everything from communications, global position systems for commercial aircraft, weather, and many other applications combined with the high cost and difficulty of repair require that these systems be designed to protect them from threat environments both during normal operation and in case of war time to protect out interests in the world of the future.

REFERENCES:
Anderson, C. PHILLIPS LABORATORY SOFTWARE CONSIDERATIONS, ADA & ADA9X. May 4, 94. Contact Phillips Laboratory/VTC, 3550 Aberdeen SE, Kirtland AFB, NM 87117-5776. tele# 505-846-0817 for copies.

AF95-090 TITLE: Miniature Voltage and Current Sensors

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: To develop miniature voltage and current sensors compatible with high-density electronics for measurement of signals caused by electromagnetic environments.

DESCRIPTION: Modern high-density electronic systems create unique instrumentation problems associated with electromagnetic effects testing. The ability to attach a current or voltage probe within an electronics enclosure at a critical measurement point on a printed circuit board is severely limited because of the physical size of the probes. This is compounded by the difficulty of routing the sensor cable through the electronics enclosure in such a way as to not destroy the electromagnetic integrity in the process. Current and voltage sensor development has not kept pace with the development of electronics and testers now find themselves unable to make critical measurements. Some attempts to make miniature voltage probes have met with limited success, but they lack the necessary sensitivity to make good measurements in a high-noise environment. The voltage and current probes should be sufficiently small to be compatible with high-density printed circuit boards to allow direct access to measurement points on those boards. Because the induced voltages caused by external electromagnetic fields are usually low in amplitude, some form of amplification should be considered prior to transmitting the signal through an instrumentation cable to an external fiber optic transmitter or recording device. Signal losses combined with background noise can severely limit internal voltage measurements without signal amplification. The amplifier associated with the voltage probe should be sufficiently small so as to fit within the electronics enclosure near the measurement point. The amplifier should be self powered from an internal or external power source. The current probe should be capable of being attached directly to wires or printed circuit board traces without physically modifying the electronics. The frequency range of interest for both probes is: 300 KHz to 1 GHz. The voltage measurement range is from 0.1V to 10V. The current measurement range is from 01ma to 10ma. The sensor cables and any power cables must penetrate a shielded enclosure in such a manner as to not change the electromagnetic shielding properties of the enclosure.

PHASE I: The Phase I effort should demonstrate the basic feasibility of a miniature probe with the necessary sensitivity and frequency response. Configuration variations, final packaging, and other possible options are not required.

PHASE II: The Phase II effort should result in prototype units fully capable of being tested under typical field conditions on-board a testbed aircraft exposed to an electromagnetic environment. All three services are involved in various electromagnetic effects programs ranging from normal EMI/EMC to advanced electromagnetic threats. Proper measurements of the effects is critical to ensuring that the proper system hardening has been achieved.

COMMERCIAL POTENTIAL: The civilian sector has similar requirements in the areas of High Intensity Radiated Fields (HIRF) standards for commercial aircraft to increased use of high density electronics in automobiles.

AF95-091 TITLE: Innovative RF Hardening Protection Device

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Survivability & Hardening

OBJECTIVE: Develop innovative, low-cost, reliable, front-door Radio Frequency (RF) protection films for InfraRed (IR) sensors.

DESCRIPTION: Existing IR systems possess large apertures that present an ideal front-door entry path for electromagnetic radiation. Significant amount of RF radiation (400 MHz - 18 GHz) can penetrate the optics, and couple to the IR sensor and supporting electronics, and generate interference levels which substantially degrade the systems operational performance. Also, when high RF power-density level reaches a sensitive component the imaging system can permanently be damaged. RF protection is critical to the survivability of the IR system and the system host (Aircraft, Satellite, etc.). A protective film should be developed to block RF by as much as 20 to 30 dB at the frequency range specified and at the same time be transparent in the IR regime, in particular 8 - 12 microns.

PHASE I: Develop preliminary design and perform analysis of different types of films and select the most promising candidate. The contractor shall develop a plan for technology transition and insertion into the future systems and other commercial ventures.

PHASE II: Develop a prototype IR window and fully demonstrate its RF and IR properties. The contractor shall deliver any hardware/software developed under this program. The contractor shall also document all work performed under this project.

COMMERCIAL POTENTIAL: The film developed under this program will be useful for several civilian applications, particularly the semiconductor industry.

AF95-092 TITLE: Sensors for Rapid Response, Global Surveillance

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop a sensor that would provide, in a few seconds, high resolution images of any selected region of the globe.

DESCRIPTION: Innovative optical/infrared sensors and sensing techniques are sought to provide fast turn around time, high resolution images of any selected regions on the globe. Military applications include dynamic battle control, battle damage assessment, and surveillance of high interest Earth scenes require high-resolution data for any local area of conflict, day or night, on demand. Civilian applications include disaster area survey and management, weather monitoring, and drug activity surveillance.

PHASE I: During Phase I, investigate and demonstrate the feasibility different sensor concepts capable of supporting a real-time, high-resolution satellite imaging system. The final report shall identify those sensors with the best characteristics to meet the objectives of this effort, a schedule for developing prototype devices, and possible commercial markets and partners.

PHASE II: In Phase II, the selected sensor technology shall be developed and implemented, producing prototype models and devices either in a full scale application or scaled to laboratory bench parameters and conditions. Prototypes developed during Phase II will be delivered to the government in operating order with sufficient documentation to allow for validation testing.

COMMERCIAL POTENTIAL: Rapid-response, high-resolution surveillance can be used for news services, environmental monitoring, disaster relief assessment and planning, oil spill reconnaissance, forest-fire detection and tracking, drug-traffic interdiction, and civil-transportation tracking functions.

REFERENCES:
Anderson, C. PHILLIPS LABORATORY SOFTWARE CONSIDERATIONS, ADA & ADA9X. May 4, 94. Contact Phillips Laboratory/VTC, 3550 Aberdeen SE, Kirtland AFB, NM 87117-5776. tele# 505-846-0817 for copies.

AF95-093 TITLE: Advanced Rocket Propulsion Technology

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop innovative rocket components, manufacturing and processing techniques, and integration technologies aimed at doubling existing rocket-propulsion capabilities by the year 2010.

DESCRIPTION: There is a need of novel, innovative approaches in the development of technologies which can double existing rocket propulsion capability by the year 2010. These revolutionary concepts, based on sound scientific and engineering principles, need offer increased performance and/or capability while at the same time yielding promising commercial applications/dual-use technologies. Specifically, technologies that can reduce environmental hazards of propellant ingredients and processing, propulsion exhaust, and rocket motors by 80% while maintaining, or surpassing, current propulsion efficiency, increase the payload capability of existing launch and upper stage propulsion systems by 7%, decrease the cost and time of manufacturing solid rocket motors by 50%, increase the reusability of cryogenic liquid rocket engines from 3 to 100 flights prior to overhaul, reduce the number of parts for a cryogenic turbopump by 80%, integrate high energy density matter into future rocket propulsion systems, and advance rocket propulsion capabilities through concerted government and industry based advances in Integrated High Pay-off Rocket Propulsion Technology (IHRPRPT) efforts. Improvements in the operability, reliability, maintainability, and cost of space launch applications, for example, might include development of novel systems which can be launched with short lead times for a relatively low life-cycle cost. Such systems would need to demonstrate high metrics in reliability and maintainability. Subsets of advanced rocket technologies would have lengthy shredouts of potential research subjects but are not stated here in detail. These technologies might include the need for combustion and plume diagnostics (i.e. application of electro-optical devices), performance predictions, effects of injector performance on exhaust plume radiation, and environmental contamination. Furthermore, bold, new advanced/non-conventional propulsion and related technological concepts and products for space activities are solicited for development. These topics include revolutionary concepts in very advanced fuels and oxidizers, metastable high-energy nuclear states, storage of antimatter in chemical matrices, nanotechnology products and techniques, enigmatic energy devices, and field propulsion thrusters. Research in these advanced rocket propulsion topics are included and structured to provide a maximum of innovative flexibility to prospective investigators.

PHASE I: The initial research in the effort will assess existing capabilities and demonstrate through bench scale evaluation of the proposed new approach, the payoff to be derived by implementing the concept.

PHASE II: Demonstrate selected, advanced rocket technology concepts beyond bench scale and conduct verification testing of the concept.

COMMERCIAL POTENTIAL: Advanced rocket propulsion technology will transition to the US commercial space launch industry, thus enabling the US industry to better compete with foreign sources for space launch opportunities by reducing the cost of inserting payloads to space orbit. Advanced rocket propulsion technology also serves the commercial sector by enhancing our ability in remanufacture and maintenance of the US ballistic missile fleet.

AF95-094 TITLE: Solar Thermal Rocket Propulsion

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop novel solar thermal propulsion components.

DESCRIPTION: The solar thermal rocket propulsion concept is to develop an Orbital Transfer Vehicle (OTV) to boost payloads from low earth orbit to geosynchronous orbit. This rocket has a theoretical capability of inserting into higher orbits, about twice the payload of current OTVs and will be reusable. The OTV consists of two energy collecting and focusing concentrators which direct sunlight into two small apertures. Within the apertures, are heat exchanging mediums, through which hydrogen gas, our propellant, flows. The hydrogen picks up heat and expands, and thrust is produced out the propulsive nozzle. For our missions, we must keep the package volume and weight of the OTV to a minimum. This means using thin film inflatable concentrators and structural supports as much as possible. They are made of thin film polyimides and are shaped like clamshells or balloons, depending on the type. Both types have a clear light transmission area and a reflectorized light collection area. Micrometeoroids

can penetrate the thin film materials easily, leaving larger holes upon exit than entrance. The concentrators' useful life will be of longer time duration if they can patch themselves instead of having to be replaced every other mission or so. Other components required for the solar rocket include but are not limited to: concentrators, thrusters, energy storage/propulsion bi-modal systems, propellant tankage, space sun-trackers, optical quality measurement devices, and laser beam power thrusters. The latest technologies in Solar Thermal Propulsion concentrator components deal with focusing laser light into apertures from ground-based systems; developing, designing and fabricating foam inflation/rigidized structures for supports; and composite material telescoping supports that are lightweight, packageable in small volumes, and self-deployable. For thrusters, the newest ideas are: matrices of small tubes that act like black body cavity receivers; and working, shaping, and applying new methods of manufacture to high-temperature exotic refractory materials for use as solar absorbers.

PHASE I: Generate a list of methods; analyze them and perform tradeoffs. Some of the factors include but are not limited to the following: usefulness in space, effectiveness in closing holes or at least reducing the size (self-repairing concentrators), cost effectiveness, ease of use, environmental concerns, autonomy, distortion of the focal image, reliability, maintainability, vulnerability, and survivability. Develop preliminary designs and perform analyses to select most promising candidate. Laboratory demonstration of the selected concept is preferred but not required.

PHASE II: Further develop, design, fabricate, and demonstrate the chosen Phase I design/concept. The contractor shall deliver any hardware/software developed, document the work performed and develop a plan for technology transition and insertion into future systems and other commercial Ventures.

COMMERCIAL POTENTIAL: The systems developed under this program will be useful for many civilian applications. The high temperature refractory materials can be used for nuclear power plant applications. The concentrator work can be transitioned into space based or terrestrial antennas. The self-repairing methods may transition into automobile/motorcycle/bicycle repair and hot air balloon repair, besides the aforementioned areas. The optical measurement systems can be used on telescopes, etc., before and after deployment in space to determine suitability.

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AF95-095 TITLE: Environmental Approaches to Solid Propulsion Technology

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop environmentally advanced approaches to solid propulsion technology that will assure full compliance with present and impending environmental legislation.

DESCRIPTION: Increases in environmental restrictions affect production, test, mission, and disposal of Air Force systems using rocket propulsion. To remain in compliance with existing and impending regulations, new approaches, materials, and processes have to be developed. This will include the development of innovative concepts for solid propulsion which transcend current propellant approaches to obtain an environmentally acceptable exhaust. (Current approaches use either an additive to combine and neutralize chlorine from perchlorate oxidizer or substitute nitrate-based oxidizer for the perchlorate.) Also included are new components or ingredients for environmentally acceptable solid rocket propellant. Additionally novel, environmentally enhanced approaches are solicited to reduce or eliminate hazardous waste streams from production (e.g., volatile organic cleaning solvent and waste water) and testing (acid and particulate laden motor exhausts), and disposal (open burn/open detonation of scrap propellant).

PHASE I: Identify and evaluate innovative concepts, outlined in the description above, that could lead to approaches that are economical, feasible, able to meet current performance criteria for an existing propulsion system, and be in full compliance with all existing and proposed or impending environmental regulations governing the areas where operations occur.

PHASE II: Demonstrate the technology identified in Phase I. Emphasis will be on performance validation. Demonstrations in the form of test motors up to 800 lbs will be performed.

COMMERCIAL POTENTIAL: Under the Federal Facilities Act of 1992 all federal installations must comply with the same environmental regulations as private, industrial concerns. Consequently, the environmental technology developed in producing, processing, testing, and disposing of propellant will be transferable to related commercial sectors. Commercial space ventures are in need of environmentally advanced propulsion systems to meet future regulations and restrictions. Similarly, related energetic materials industries (i.e., pyrotechnics and explosives) could benefit from the technology developed in this program. Capability as a form, fit, and function for a specified system as predicted in Phase I will be of high value, not only to the services, but to commercial space ventures as well.

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AF95-096 TITLE: Electric Propulsion Thruster and Materials for On-Orbit Applications.

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop and validate design concepts or materials for improving the capabilities of electric propulsion thrusters for on-orbit applications.

DESCRIPTION: Electric propulsion thrusters can achieve on-orbit maneuvering and station keeping capabilities that more than double those of chemically based systems. With an electric system, substantially greater amounts of energy can be deposited in the flow. The performance of these devices increases as more energy is added to the flow, but is finally limited by thruster material properties and system energy is added to the flow, but is finally limited by thruster material properties and system energy loss mechanisms. Due to the rapid advance of materials technology and numerical and experimental analysis tools, the potential for significantly increasing both the physical capabilities of the thrusters and their underlying operating efficiencies is great. The goal of this SBIR effort is to develop and validate innovative electric propulsion (EP) design concepts or materials capable of near term application. One of the two approaches can be considered per SBIR proposal. Projects involving both enhancements to existing and new thruster configurations can be considered. Strong emphasis should be placed on near term application of the results to both the military and commercial satellite propulsion. A key consideration should be the ease of integration into existing satellite systems. The thruster should be optimized for on-orbit maneuvering and station keeping missions; maximum available power from 0.5 to 10 kW electric and satellite specific power from 1 to 5 W/kg can be considered representative. One or both mission types can be considered. For phase I design concept efforts, a strong emphasis should be placed on the validation of the design that is expected to provide the stated capability enhancements; experimental and theoretical methods can be considered. For phase I material efforts, a strong emphasis should be placed on the identification, fabrication and testing of the EP materials expected to provide the stated capability enhancements; testing should as accurately as possible

reflect the environment of the material during thruster operation. For both types of efforts, government and commercial test and evaluation facilities may be utilized; documentation of efforts to secure these facilities should be provided. Based on the results of these tests, thruster performance should be estimated and improvements quantified.

PHASE I: Develop and validate electric propulsion thruster concepts or materials resulting in performance capabilities significantly exceeding those of existing EP devices; primary interests are performance, minimal impact on spacecraft operations and systems, minimal spacecraft contamination, environmental compatibility, and lifetime. The focus of the effort should be on the near term applications of station-keeping and on-orbit maneuvering.

PHASE II: Apply the results of Phase I to the design, fabrication, experimental validation, and optimization of EP thruster performance capabilities. The design process is expected to be iterative with the thruster with the best overall performance being reproduced and be deliverable at the end of the phase II period.

COMMERCIAL POTENTIAL: Dual use commercialization would occur through the development of flight quality electric propulsion systems for satellite and space experiment applications. Improved electric propulsion thrusters will extend mission lifetime, increase spacecraft maneuverability and reduce system mass. Both mission capability and profitability will increase through the introduction of these thrusters into the marketplace. The outlook for commercialization therefore appears quite favorable.

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AF95-097 TITLE: Apparatus for the Testing of Solid Cryogenic Mechanical Properties

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: An apparatus for testing the mechanical properties of a variety of next generation cryogenic solid fuels.
DESCRIPTION: The USAF Phillips Laboratory, Propulsion Directorate, is currently researching a class of advanced rocket propellants-cryogenic solids. These are room temperature gases or liquids that have been solidified at low temperatures. Typical examples include solid oxygen solid hydrogen, mixtures of cryosolids, or cryosolids with additives. Before using cryosolid materials in any rocket propulsion application, an in-depth examination of their mechanical properties is required at a variety of cryogenic temperatures down to superfluid liquid helium temperatures. These properties include their tensile, flexural, shear and compressive strength, elastic moduli, surface tension and hardness. To perform these studies, a generalized mechanical properties testing device is required which will both solidify small quantities of these materials at defined formation parameters and allow testing at precisely controlled cryogenic temperatures. This will be enabling technology leading to an application for high energy density propellant concepts in Air Force space programs.

PHASE I: Identify properties and propellants to be tested, and deliver a detailed design of a cryogenic testing device.

PHASE II: Develop a working prototype of the system as a proof of principle device to be delivered to the government. This device will be a fully operational, working unit and shall be demonstrated prior to delivery.

COMMERCIAL POTENTIAL: The prototype could be further developed to meet the needs of commercial, government and academia users for the mechanical testing in a variety of areas including cryogenic superconductors, integrated circuits as well as propulsion related materials. be further developed to meet the needs of commercial, government and academia users for the mechanical testing in a variety of areas including cryogenic superconductors, integrated circuits as well as propulsion related materials.

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AF95-098 TITLE: Advanced Dual Use Diagnostics for The Upper Atmosphere

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Telecommunications

OBJECTIVE: Develop advanced dual use of the upper atmosphere for characterizing basic phenomena, assessing RF propagation effects and environmental monitoring

DESCRIPTION: Improved diagnostics for characterizing the earth's atmosphere above 50 km are required for better determination of atmospheric effects on civilian and military communication and surveillance systems and environmental monitoring. Diagnosis of the entire upper atmosphere is important, but special emphasis may be placed on mesospheric measurements due to its importance in environmental monitoring and the relative scarcity of existing diagnostic techniques for that region. Proposed diagnostics should assess dual use commercialization potential. Design criteria should include: instrument portability, reliability, ease of operation and maintainability, and the use of commercial off-the-shelf components when possible. Physical quantities of interest include neutral and ion composition, density, temperature, winds, collision frequencies, recombination and diffusion rates, and electric fields. Appropriate responses may include proposals for instruments based on completely new diagnostic principles, improvements of known diagnostic techniques by exploiting recently available technologies, and the development of new analysis techniques or human interface systems to substantially improve the information yield from existing diagnostics. In addition to the natural atmosphere, consideration should be given to diagnosis of atmospheric regions modified by powerful high frequency (hf) transmissions such as those produced at the high power auroral stimulation (HIPAS) facility, Arecibo observatory, and the projected high frequency active auroral research program (HAARP) facility; diagnostics specifically designed to work in conjunction with these transmitters are acceptable.

PHASE I: Develop a diagnostic concept and produce a detailed design for an experimental instrument or algorithm providing improved measurements based on that concept.

PHASE II: Based on Phase I design, construct or further develop, and demonstrate the instrumentation or algorithm. Delivery shall include documentation on the operation and maintenance of the delivered hardware and/or software.

COMMERCIAL POTENTIAL: In addition to addressing military requirements for secure, reliable communications and surveillance systems, the diagnostics developed under this program have broad application to other disciplines. Within the government, new and improved atmospheric diagnostics have concrete applications for nuclear ban treaty verification and theater missile defense strategies. Diagnosis of the mesosphere is becoming increasingly important as a means of environmental monitoring for both the military and civilian sectors; such instruments can be effectively applied to expanding initiatives on global change in both the U.S. and abroad. As has happened in the past, new designs for diagnostics of the ionized upper atmosphere may be readily adapted by the plasma fusion community (e.g., incoherent scatter, langmuir probes, rf sounding) to investigate laboratory-scale plasma environments. Additionally, these diagnostics can satisfy the needs of the rapidly expanding information transfer technology market as the telecommunications industry implements the wireless communications component of the national information infrastructure initiatives.

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AF95-099 TITLE: Optical Sensors for Geophysical Remote Sensing, Environmental Monitoring, Target Characterization

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop innovative remote sensing instrumentation for geophysical research, environmental and target characterization.

DESCRIPTION: The Air Force conducts geophysical research to gain further understanding of the environment between the earth and the sun and determine its effect on Air Force systems and operations. The Air Force also has the responsibility to measure the effect of Air Force operations on the environments. Phillips Laboratory has developed a variety of advanced remote sensing instrumentation to aid in these efforts, but is interested in new sensors that leverage recent progress in commercial technology. Examples include passive optical systems such as ultra-violet, visible, or infrared radiometers, spectrometers, and imaging spectrometers, and active systems such as Lidar. Many commercial technologies such as those in detector arrays, lasers, electronics, and data storage and processing are emerging that could by developed into innovative systems for remote sensing of the geophysical environment. The instrumentation will be utilized in ground-based, airborne, and space applications. Specific instrumentation of interest include: imaging spectrometers, which simultaneously obtain both spatial and spectral characteristics of a background or target; imaging multispectral radiometers, which measure the spatial and temporal characteristics of a target or background simultaneously at two or more wavelengths; aerosol monitors, which can monitor and characterize aerosols deposited in the stmosphere by aircraft and missile engines; high spectral resolution ir sensors for middle atmosphere temperature profiling having spectral resolution of 0.1Cm-1 to 0.01Cm-1; very sensitive near ultraviolet/visible/near infrared spectrometers, covering the spectral range from 300 nm to 900 nm, the spectrometer to be used to obtain spectral data of rocket plumes, measure atmospheric pollution at levels as low as parts-per-trillion, and observe radiations from the ionosphere during heating by ground-based, high-power, high-frequency transmitters.

PHASE I: An analysis shall be conducted which compares the candidate design to current technology in terms of sensitivity, spectral and/or spatial resolution, temporal resolution, size, weight, power consumption, etc. The effort should also include an investigation of how the new technology can be applied to other military and commercial applications.

PHASE II: Develop a working prototype of the sensors and demonstrate operation in a laboratory environment. Tests and calibration shall be conducted to determine how effectively the design meets the requirements of the intended application.

COMMERCIAL POTENTIAL: The sensors developed under this program will be useful for non-military applications, such as pollution monitoring, environmental change monitoring, process monitoring in manufacturing, and remote sensing of earth resources.

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AF95-100 TITLE: Optical Parametric Oscillator Based Lidars For Remote Sensing Of Chemicals

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop OPO based lidar technology applicable to environmental compliance monitoring of chemical clouds/plumes and chemical agent defense.

DESCRIPTION: New advances in solid state lasers, laser diodes, and non-linear optics have progressed to a level where new frequency agile OPO based solid state laser transmitters for differential absorption lidar (dial) systems can be expected which have average output powers of 50 watts. The very broad band tunability of OPO's along with their potential high conversion efficiency makes them ideal for consideration in dial applications. Depending upon the application and required output energy, such a system has the potential for being compact, rugged, and achieve a high time between failure. If operated in a single frequency mode to allow heterodyne detection, improved signal sensitivity and an added doppler sensitivity could be achieved. The Air Force has requirements for environmental compliance monitoring of emission plumes during activities such as open burning disposal of munitions and hazardous wastes, launch activities, range tests, hazardous site remediation activities, and military industrial activities. Current monitoring technologies are not adequate to provide all of the necessary quantitative data required. Point sampling techniques, such as air samplers, can only provide information about one point in the plume, which may not be representative. Passive optical sensors can only provide column content along the pointing direction. Similar limitations of these sensors also apply in applications for monitoring for chemical agent defense. An OPO based dial system would be able to provide large area, range resolved sampling and mapping of the plumes or clouds by scanning the laser beam and using the time of flight of the light pulses to determine an accurate range for each sample. Such a system would not only be able to detect a cloud, but also be able to determine its extent, rate of drift and diffusion, and variations in concentration throughout its measured volume. Application of such a dial lidar system could be from ground and aircraft based platforms. The development and demonstration of a prototype ground based OPO dial system is sought which has the capability to detect chemical clouds with different absorptions of at least %% to ranges over 5 kilometers. The emphasis of the effort is in developing the laser transmitter technology and not in developing new lidar receivers or data acquisition hardware software.

PHASE I: Develop a conceptual design of the OPO based dial lidar system operating in the eyesafe 2 to 9 micron wavelength region, as required by target chemicals. Candidate environmentally sensitive chemicals for testing and demonstration will be selected.

PHASE II: Develop a working prototype of the system suitable for ground-based field testing in conjunction with emissions from on-going Air Force operations. In addition, the contractor will conduct an analysis on scaling the technology to higher powers to achieve longer measurement ranges and suitability for airborne applications against chemical warfare agents.

COMMERCIAL POTENTIAL: The ability to remotely detect and characterize chemical clouds and plumes with high sensitivity and excellent range resolution has many applications beyond the military ones cited above. Many commercial industrial operations, hazardous remediation activities, and compliance monitoring requirements are similar to those the military must abide by. Further, this technology could be expanded upon by the commercial sector into other areas such as gas leak detection, plume transport model validations, and new types of hand-held point sensor applications. The potential for airborne operation offers opportunities for large area measurements of climatically important chemicals for global climate change applications.

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AF95-101 TITLE: Innovative High Resolution IR Sensors

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop innovative, small and rugged, reliable, low mass, ultra-high resolution infrared (IR) sensor for middle atmosphere temperature profiling.

DESCRIPTION: There are strong needs for the sounding of middle atmosphere temperature from DoD, NOAA, and the scientific community to meet the requirements of DoD operations, numerical weather forecasting, stratosphere ozone study, global climate change studies, high altitude re-entry constraints, etc. A microwave radiometer is one potential technique for the remote sensing of middle atmosphere temperature, but it is generally bulky, heavy, and very expensive. Zeeman splitting is also cause for some uncertainties in the brightness temperature measurements and retrieved temperature (as a function of geomagnetic coordinates). Since there are almost no clouds within the stratosphere/mesosphere to interfere with appropriately selected nadir-viewing IR sensor operations (e.g. detectors centered on very strong spectral lines), such an IR sensor is not necessarily at a disadvantage compared with a microwave radiometer in terms of all-weather operation. The challenge for the vertical sounding of the stratosphere and lower mesosphere temperature is to have very high spectral resolution (to isolate the strongest absorption features), in the order of 0.01 cm-1 to 0.1 cm-1, with adequate signal/noise. Innovative techniques (such as the Multi-Order Etalon Sounder (MOES) that exploit the periodic transmission characteristics of the Fabry-Perot interferometer coupled with the periodicity of CO2 spectra) that can lead to the development of ultra-high spectral resolution, rugged, small mass, reliable, rapidly deployable IR sensors for the remote sensing of middle atmosphere temperature profiles are sought.

PHASE I: The contractor shall carry out preliminary designs for the innovative techniques, including a conceptual design of the sensors and retrieval simulation to demonstrate the potential sounding accuracy.

PHASE II: The contractor shall develop a working prototype of the IR sensors as a proof of concept. The contractor shall also conduct necessary measurements to confirm that spectral resolution and signal-to-noise requirements have been met.

COMMERCIAL POTENTIAL: After the successful demonstration of the innovative IR sensors concept in Phase II, the sensor can be further developed to be included in the DMSP and NOAA operational satellites to provide the middle atmosphere temperature profiles to DoD, scientific, and other user communities. The new sensor concept will also have other potential applications in the ultra-high resolution remote sensing of the environment. For instance, the new sensor will also have a variety of commercial applications in air pollution monitoring, industrial process control, and automobile emission monitoring. It can be used as a tropospheric carbon monoxide (CO) sensor, a remote sensor for automobile tail-pipe CO/CO2 emission measurements, and a rugged and reliable real-time monitor of industrial gases (such as SO2, N2O, NH3, CO, CO2, etc.) in the chemical and utility industries.

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AF95-102 TITLE: Neural Networks for Weather Impact Decision Aids In Activity Planning

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Develop artificial neural net software that predicts the impact of weather on weather-sensitive activities at a given location for 24 to 72 hours in the future.

DESCRIPTION: Artificial neural networks application where many variables can influence the outcome of an event, and where it is not possible to develop an exact physical/mathematical relationship between the variables and the event. Predicting the impact of weather on the performance of electro-optical weapons and target acquisition/navigation system represents such an event. To date the application of artificial neural network technology to the realm of weather prediction has been limited. Weather forecasters intuitively take into account many variables in long range predictions beyond 24 hours for which there are incomplete physical/mathematical equations or non-deterministic effects. Furthermore, for application in day-to-day operations, a prediction system is needed that does not fail catastrophically when noise and missing data occur; and replicates a forecasters intuitive feeling about forecast accuracy under given weather conditions. What is desired is the application of artificial neural net technology for predicting the impact of weather at a point on electro-optical precision-guidance and target acquisition/avoidance systems (IR, TV, and laser) in decision support/mission planning systems for 24 to 72 hours in the future. The impact can be categorical such as little, marginal, uncertain, or severe impact.

PHASE I: Phase I should further develop the concept and demonstrate its feasibility.

PHASE II: Develop prototype software for potential use in Air Force mission planning systems.

COMMERCIAL POTENTIAL: Such software would have wide application in categorical predictions of the impact of weather for planning and executing commercial operations such as weather sensitive construction, transportation, agriculture, etc.

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AF95-103 TITLE: A Cloud Profiling Remote Sensor For Atmospheric Research and Applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop a low cost, reliable, portable instrument to measure cloud layer characteristics for basic and applied atmospheric research.

DESCRIPTION: Knowledge of the distribution, structure, and density of nonprecipitating clouds is essential to a wide variety of Air Force applications, including the development and testing of surveillance and guidance systems and in the development and testing of surveillance and guidance systems and the development of realistic cloud scene simulations. However, conventional remote sensing techniques, such as weather radar, satellite photography, or lidars, are of only limited use in detecting and characterizing these low density clouds. Weather surveillance radars are unable to detect most non-precipitating clouds, satellite sensors provide information only about cloud tops, and ground-based lidars can observe only the lowest cloud layer in most cases. A sensor is required that will provide information about the spatial structure, microphysics, and internal kinematics of multiple cloud layers, up to a height of about 15 km. A possible candidate technology for the application is that of millimeter-wave radars; these have an advantage over conventional weather surveillance radars in detecting non-precipitating clouds, due to the enhanced scattering from small water droplets at millimeter wavelengths. Technical issues of the remote sensing of clouds have been discussed in a general context (1) and in relation to 35-GHz radars (2,3) and 95-GHz radars (4,5). The previously high cost and limited capability of millimeter wave components has largely restricted millimeter-wave atmospheric research to single polarization, incoherent measurements of cloud backsatter. The few more advanced cloud detection radars in existence are research-oriented systems, not designed for quantity production or proven for long-term,

automated operation. Recent advances in millimeter-wave technology and decreasing prices of components have made possible the construction of a moderately priced millimeter-wavelength fully polarimetric doppler radar for cloud profiling. Other technical approaches may be acceptable if they can provide the desired cloud measurements. In Phase I the contractor will evaluate alternative technical approaches to the measurement of clouds, select the most promising approach, and design a system that can be constructed within the constraints of Phase II. The instrumentation test facility operated by Phillips Laboratory at Otis National Guard Base, Massachusettes, can be made available as necessary for testing and evaluation during Phase II.

PHASE I: Produce one or more practical designs for a cloud sensor, including the specification and pricing of all major components and construction needs.

PHASE II: The contractor should fabricate a working prototype of the chosen system design. Also, fully test and evaluate its performance with emphasis on its cost and long-term reliability.

COMMERCIAL POTENTIAL: The sensor developed under this program will immediately contribute to the atmospheric research community by providing the most detailed cloud structure data available to date. Such data will be applicable to research in cloud physics, atmospheric radiation, and climatology. The cost of these sensors should make them feasible for civil aviation applications requiring cloud height, layering, density, turbulence, and icing information. Mass production and installation of these sensors at airports and along flight corridors may prove invaluable.

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AF95-104 TITLE: Portable Ultra-High Sensitivity Plume Detection

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop an innovative approach for ultra-low concentration in-situ measurements of pollutants in combustion plumes.

DESCRIPTION: New advances in the technology for measuring products of combustion processes will accelerate progress in reducing environmental impact of these processes. These techniques must involve miniature, portable systems to allow measurements at realistic operating conditions for the system being measured. The best present techniques for measuring pollution products are laboratory based and not amendable for measurements in real-world scenarios. Jet exhausts require detection at normal operating altitudes near the exhaust source as well as longitudinal and radial surveys to pin down the evolution of exhaust products. Rocket plume effects throughout the troposphere and stratosphere require in-situ measurement for understanding of their effects. Similarly, the evolution of smokestack plumes needs to be tracked as a function of altitude and distance. Cost-effective measurement of these parameters requires accurate miniature instrumentation capable of being inserted in instrumented pods of survey aircraft and into the new breed of remotely piloted vehicles (RPV), such as the Perseus. The challenge is to combine the best possible measurement technique(s) into a small portable package.

PHASE I: Produce a conceptual design of a system. Specifications will be provided for the performance of the apparatus, including a comprehensive list of pollutant species that can be measured, sensitivity range of the measurement, the time resolution and accuracy of the measurement, and the operating pressure range of the device. The design should include

estimated size, weight, measurement, duration, and power requirements. Provide a strawman integration plan for including the apparatus into a Perseus-sized payload as a demonstration of the feasibility of the approach in meeting the portability requirements for commercialization.

PHASE II: Develop a working prototype of the system acceptable for demonstration tests in an instrumented aircraft measurement pod. Also deliver complete performance report capabilities of their apparatus for providing a comprehensive combustion/air pollution measurement platform.

COMMERCIAL POTENTIAL: The instrumentation developed under this program will be useful for many civilian applications. The portable, broad range, ultra-high sensitivity pollution measuring device developed under this program could find applications in jet engine development, detection and monitoring of waste site emissions, and rocket engine development. The instrumentation would be immediately applicable in meeting the needs of several NASA research programs.

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AF95-105 TITLE: Improved GPS Ionosphere Correction Modeling

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Navigation, Guidance & Vehicle Control

OBJECTIVE: Construct and test an ionospheric correction model for single frequency GPS users which can be updated with real-time inputs.

DESCRIPTION: The earth's ionosphere can often be the largest source of range and position error for the GPS single frequency user, both military and civilian. The present ionospheric correction algorithm was designed in the mid-1970s, and it is not able to accept near-real-time updates. It corrects for only 50 to 60% of the ionospheric range error in the mid-latitudes and is even worse at in the equatorial latitudes. Military single frequency GPS users, with capability for removing selective availability effects, and civilian users of wide are differential GPS, will encounter times and geographic regions where the ionospheric range error is unacceptably high. Modern ionospheric models are too complex to be used directly. Simpler model representations for the GPS user are required which are capable of being updated with near-real-time-data from one or more direct ionospheric measurements. Backward compatibility to users with equipment having the present GPS ionospheric correction algorithm is also required.

PHASE I: Further develop the overall concept and discuss how the new model is to be made compatible with the existing ionospheric correction algorithm, and tradeoffs for various real-time updating options.

PHASE II: Deliver a finished model with coefficients for all solar and geophysical conditions. This model should be fully-installed in a prototype GPS receiver with firmware for requisite updating capability, completed and tested against a representative set of dual-frequency GPS ionospheric data. This will insure that the receiver-installed model is correct.

COMMERCIAL POTENTIAL: The final model has application for most commercial users of GPS including improved positioning of commercial and general aviation civilian aircraft, both highway commercial and pleasure traffic control, precision geodesy, precise time synchronization and transfer for modern digital communication systems, and other high accuracy civilian timing and positioning applications.

REFERENCES:

Ionospheric Time-Delay Algorithm for Single-Frequency GPS Users, J.A. Klobuchar, IEEE Trans, on Aerospace and Electronic Systems, V AES-23, No.3, pp 325-331, May 1987

AF95-106 TITLE: New Laser Concepts For Air Force And Private Sector Applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop novel lasers for communications, countermeasures, remote sensing, and advanced alignment systems.

DESCRIPTION: The next generation of laser devices for the Air Force must be high power, efficient, cost effective, and extremely compact sources. Applications exist for a variety of monolithic semiconductor and solid state laser sources that can provide stability, reliability, and ease of operation. Examples include sources which incorporate micro-optics, high modulation rate optical modulators, average output powers up to 50 watts, wavelengths in the eye safe (>1.5 - microns) and ultraviolet (<0.4 micron) regions, and concepts that integrate the laser, output optics, cooling, sensors, and drive electronics into a single compact unit. Proposer should consider compatibility/optimization with available or new sensor technology. Proposers may submit new concepts for laser devices, micro-optic technologies, thermal managment techniques, die bonding, materials development, modulation schemes, and other technologies relevant to the next generation of Air Force and private sector applications. Novel, broad area, single aperture semiconductor lasers; monolithic solid state lasers; and unique, high power 1 and 2 dimensional array architectures will have application in future Air Force communications, electro-optical and visual countermeasure, physical security, illumination, and remote sensing missions. Commercial applications for this technology include environmental monitoring, wind sensing, read/write data storage, communications, medical, and law enforcement.

PHASE I: Develop preliminary designs and perform analysis to select the most promising candidate(s) for applications of interest. Laboratory demonstration of the selected concept(s) is preferred but not required.

PHASE II: Further develop and demonstrate the chosen Phase I design(s)/concept(s). The contractor shall deliver any hardware/software developed, document the work performed and develop a plan for technology transition and insertion into future systems and other commercial ventures.

COMMERCIAL POTENTIAL: The lasers and concepts developed under this program will be useful for many civilian applications such as remote sensing for pollution monitoring of industrial plants and waste sites, process monitoring in manufacturing, identification of agricultural and plant species and growth conditions, and oil surveys. Medical applications that may benefit include spectroscopic techniques for glucose monitoring, photo dynamic therapy for cancer, tissue cutting, and cauterization. Laser wind sensing concepts will transfer to commercial aviation for wind shear detection and wake turbulence studies. Law enforcement applications include non-lethal protection devices and perimeter security systems. Short wavelength lasers will apply to high density data storage and retrieval as well as high brightness color video displays and visual countermeasures for security and law enforcement applications.

REFERENCES:
No references are identified since this topic covers such a broad range of technology and is intended as a solicitation for new and creative ideas.

AF95-107 TITLE: Technology Transfer/Dual Use - Medical Applications of Lasers and/or Imaging Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Transfer of Lasers and Imaging Directorate Technology to the Medical community. Develop Medical diagnostic and surgical products using PL/LI laser and imaging technologies.

DESCRIPTION: The Lasers and Imaging Directorate of the Phillips Laboratory has developed high power chemical, solid-state, and diode lasers and imaging systems for military applications. Both of these areas include technologies that are suitable for medical applications. Recent advances in laser and optical materials have led to the development of new types of lasers and imaging systems with substantially improved performance. These advancements include development of more powerful lasers at wavelengths useful for non-invasive surgical or diagnostics in medicine and the development of novel compensated imaging and hyperspectral sensing techniques which provide dramatically improved image quality that may be useful for medical diagnoses.

PHASE I: An in-depth assessment of potential commercial medical applications of a selected laser and/or imaging technology will be required. As a result of this assessment, the initial necessary medical product concept refinements will be determined and a concept will be designed.

PHASE II: Build or fabricate, test and validate a laboratory demonstration model or prototype based on the commercial medical applications assessment and the design refinements.

COMMERCIAL POTENTIAL: The Phillips Laboratory is committed to finding commercial applications for its military developed technologies. The Lasers and Imaging Directorate considers the area of medical applications of lasers and/or imaging technologies to be an ideal dual use area for commercialization of LI technology. LI requires partners in the private sector medical products community to obtain this goal.

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Andersson-Engels, S., et al. "Fluorescence Diagnosis and Photochemical Treatment of Diseased Tissue Using Lasers: Pt1," Anal Chem (US), V.61 no.24, Dec 15, 89, pp.1367A-1373A.

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AF95-108 TITLE: Environmental Applications Of Semiconductor Lasers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Investigate environmental applications of semiconductor lasers and determine which applications will benefit most from their unique properties.

DESCRIPTION: Recent and accelerated improvements in materials growth, processing, and architecture of semiconductor lasers have made these laser sources practical for use in environmental monitoring/analysis. Solid improvements in beam quality, mode control, frequency and thermal stability, and power points to a future in which diode lasers will play a significant and potentially dominant role in environmental monitoring. Further, the advances in semiconductor quantum-well lasers have enabled materials engineers to "dial in" the laser emission bandwidth (i.e., frequency) over the range .63 to 2.2 um (visible to near infrared). This allows any molecular species with absorption bands in this frequency range to be a candidate for monitoring via diode laser spectroscopy. For example, molecules which potentially could be monitored in this range include CO2, CO, NO2, CH4, O2, HC1 HBr, HF, HI, H2S, NH3, and H2O. This short list contains two key greenhouse gasses (CO2 and CH4), species that play critical roles in atmospheric chemistry (NO2, CH4, HC1), gasses important in industrial processes (the halo-acids, H2S, O2, and H2O), and a potentially deadly combustion by-product, carbon monoxide, often found in the home environment. At present, the majority of diode laser environmental monitoring/spectroscopy systems have been laboratory based. Given the advances noted above and the co-technological advances in monitoring methodologies (e.g., ultralight platforms such as ultralight remote controlled airplanes and kites for atmospheric monitoring, fiberoptic probes for remote sensing, etc.) it is desirable to research and develop fieldable, rugged, and sensitive diode laser based environmental monitoring systems. It is important that the use of the semiconductor based laser application have clear advantages over conventional techniques.

PHASE I: Select a promising application utilizing semiconductor lasers. The contractor shall perform preliminary investigations to determine laser specifications for the chosen application and required system design parameters. At the end of Phase I, a preliminary design will be delivered.

PHASE II: Build and optimize the laser system by conducting tests in the operational area in which it will be used. A prototype will be delivered by the end of Phase II.

COMMERCIAL POTENTIAL: These semiconductor lasers will be useful in battlefield situations in which toxic gases may be released. They will also be useful for monitoring ambient air quality in enclosed military vehicles (e.g., airplanes, submarines, etc. Further, direct in-situ monitoring of materials important in military applications, such as lubricants, fuels and other liquids, e.g., water) can indicate purity, degree of degradation, etc. Civilian applications of this technology include toxic gas monitoring (either home, workplace, or industrial site-perimeter monitoring), mine safety monitoring, monitoring of pollutants in stack gasses, on-line monitors of combustion or chemical processes, measurement of atmospheric species, ground water monitoring, and evaluation of common liquids, e.g., engine oil.

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Lo, W. (ed) TUNABLE DIODE LASER DEVELOPMENT AND SPECTROSCOPY APPLICATIONS. Proceedings of SPIE - The International Society for Optical Engineering, Vol.438, 1983.

AF95-109 TITLE: 1-3 Micron Tunable Diode Pumped Solid State Laser Sources

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Directed Energy & Kinetic Energy Systems

OBJECTIVE: Develop an efficient compact 1-3 micron tunable laser to optically pump gas phase laser down converters to 3-5 microns.

DESCRIPTION: An ideal laser technology for applications to tactical airborne countermeasures would provide both access to the 3-5 micron special region in the near term and later growth to the 8-12 micron band. In addition to military applications reliable efficient laser sources between 2-12 microns may find many commercial applications such as eye-safe laser radar, remote sensing of atmospheric constituents, and wavelenght specific medical applications. For the military application an appropriate technology must also meet many performance requirements such as pulse energy, repetition rate, size, weight, and reliability. There is currently no clear choice for a fully satisfactory device technology for this application. It is anticipated that the eventual solution will be solid-state lasers pumped with diode laser arrays and perhaps frequency shifted by means of nonlinear optical phenomena, it is not clear that even in the long term NLO techniques will be sufficiently rugged to survive the military environment. However, the compactness, low weight, and higher efficiencies associated with solid-state lasers will make these devices leading contenders for many military applications as well as private sector applications for years to come. The Phillips Laboratory is currently conducting a research program using laser pumped molecules as gas phase frequency down converters. Single pulse experiments using commercial tunable laser sources have shown conversion efficiencies between 25-30% in HF, HCL, and HBr. Inversions in these lasers are produced by pumping with a narrow band ~200mz tunable laser source on the O-2 vibrational overtone transition and then lasing on the 2-1 vibrational fundamental. Because of the demonstrated high single pulse conversion efficiencies the PL is interested in scaling the laser pump source to high average power (1-5 KHz 25-30watts).

PHASE I: The goal of this effort is to determine if a solid-state laser pumped laser is a viable concept for airborne tactical applications in terms of size, efficiency, and wavelength selectivity. Then, if feasible, a brassboard prototype shall be built and demonstrated. The end product of Phase I will be a technical report on the methods/techniques to generate 1-3 micron narrow band tunable high average power pump laser.

PHASE II: The end product of Phase II will be a detailed design, fabricate and experimentally test a 1-3 micron high average power tunable laser.

COMMERCIAL POTENTIAL: In addition to military applications compact Mid-Infrared Laser sources may find commercial uses. These include sensing (global wind sensing, and low altitude wind shear detection), medical markets that require laser sources that are eye-safe but strongly absorbed in tissues, eye-safe laser radar, and remote sensing of atmospheric constituents.

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Miller, H.C., et al. "Gas-Phase Optically Pumped Infrared Lasers." in INTENSE LASER BEAMS AND APPLICATIONS. SPIE Proceedings 1871, 1993, pp. 2-6.

AF95-110 TITLE: Compact Continuous Wave Ultraviolet Laser

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a near diffraction-limited compact continuous wave (CW) ultraviolet (UV) laser.

DESCRIPTION: Continuous wave ultraviolet lasers are useful for hardcopy recorders and master disking of compact disks and optical disks. The small wavelength allows greater area densities than visible lasers. Recent commercial developments have resulted in a doubled argon laser. This laser requires water-cooling, substantial power (greater than 10 kVA), and is not portable. The advent of diode-pumped solid-state lasers has resulted in compact visible lasers with low power requirements. Progress has also been made on visible room temperature semiconductor lasers. Doubling of either of these lasers to the UV would result in a desired portable compact CW UV laser with low power requirements. A laser needs to be developed with the following specifications: (1) Wavelength between 240nm and 270nm with a preference for wavelengths between 240nm and 257nm; (2) Diffraction-limited to within 2X; (3) Input electrical power less than 3 kVA; (4) Portable; (5) Turn-key operation and; (6) Packaged for OEM applications. The laser, all support electronics, and cooling must be supported by the 3 kVA electrical power limit. The laser must be capable of being operated by untrained personnel.

PHASE I: Design a portable compact CW UV laser and conduct supporting analysis and/or computer simulations.

PHASE II: Based on the Phase I design, develop or fabricate, demonstrate and deliver a prototype compact CW UV laser.

COMMERCIAL POTENTIAL: These lasers are useful as light sources for commercial and military high resolution recording systems, especially portable systems. They are also useful in master disking systems for creating compact disks and video disks, in the semiconductor industry for high resolution photolithography.

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AF95-111 TITLE: Beta Barium Borate (BBO) Anti-Reflection UV Coating

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop a reliable method for anti-reflection coating BBO for ultraviolet and visible radiations.

DESCRIPTION: Beta barium borate (BBO) is used as a frequency doubling crystal for converting visible light to the ultraviolet (UV) due to its relatively high doubling efficiency. As with any piece of optics, there reflection losses reducing the transmitted beam. The presence of any loss is often magnified in many frequency doubling designs by the use of high Q, resonant cavities. The coupling efficiency of the input fundamental light can be increased by either cutting the crystal at Brewster's angle or anti-reflection (AR) coating the crystal. Although the Brewster angle cut minimizes the fundamental frequency reflection, the harmonic frequency reflection losses are increased. A dichroic anti-reflection coating would transmit both the fundamental and harmonic frequencies. BBO crystals have been AR-coated in small lots to reduce the incident reflection losses but the technology has been unreliable. The reliability rate is not sufficient to allow their use in commercial systems. A reliable AR coating process will result in higher effective doubling efficiencies. Possible beneficial side effects of an AR coating are additional protection of the crystal from the environment (BBO is hygroscopic) and a possible increase in the optical damage threshold. A coating should be designed to decrease the fundamental reflection losses to less than 1% and the frequency doubled harmonic frequency reflection losses to less than 2%. The fundamental frequency is single mode between 480nm and 540nm. The harmonic frequency is doubled the fundamental frequency and is also single mode. The coatings should withstand continuous-wave irradiation for fluences up to 1000 W/cm sq. The reliability of producing a successful coating upon a BBO crystal should not impact the delivery schedule of an OEM manufacturer relying upon receiving an AR-coated BBO crystal.

PHASE I: Design a dichroic anti-reflection coating for Bata Barium Boarate (BBO). Also, develop preliminary coating process designs.

PHASE II: Based on the Phase I designs, coat, test and deliver Anti-reflective (AR) coated BBO crystals specifically for operation at 488 nm, 514 nm, and 532 nm.

COMMERCIAL POTENTIAL: Beta Barium Borate (BBO) is used as a frequency doubling crystal in lasers that are used for both commercial and military applications. Some of the commercial uses for the lasers are master disking for creating compact disks and video disks, high resolution photolithography in the semiconductor industry, and high resolution hardcopy recorders.

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AF95-112 TITLE: Absorption Reduction In Silver Thiogallate

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials

OBJECTIVE: Reduce surface and bulk absorption in the nonlinear crystal AgGaS2.

DESCRIPTION: Optical parametric oscillation allows the generation of frequency-tunable radiation over a wide range in a variety of pulse formats. In nearly all the pulse formats (continuous wave, Q-switched pulses, Q-switched modelocked pulses, or continuous-wave modelocked pulses) the absorption of the nonlinear material plays an important role in the design and construction of this frequency-tunable device. In some cases, high absorption can prohibit the construction of such a device. Silver thiogallate, AgGaS2, represents an excellent candidate for the nonlinear material to generate tunable radiation throughout the infrared spectrum. The transmission window extends from 0.5 um to 12 um and is phase matchable with a 1 um- or 2 um-wavelength pump laser. The thermal conductivity is 11 Wm-1 K-1, which is about ten times larger than crystals like KTP, LBO, and BBO. In addition, the coefficient describing the material's nonlinearity is more than an order of magnitude larger than crystals like KTP, LBO, and BBO. These features make AgGaS2 an ideal candidate for generating tunable wavelengths in the range between 2 um and 12 um. Recently, a technique was analyzed theoretically and demonstrated experimentally that combines optical parametric oscillation with sum-frequency generation to efficiently produce frequencies between the pump frequency and two times the pump frequency. When this technique employs AgGaS2, the device can produce tunable radiation over the visible spectrum with a 1 um-wavelength pump source. One of the limiting features of AgGaS2 is its relatively large surface and bulk absorption. Typical values for the bulk absorption in the range from 1 um to 10 um are 0.01 to 0.03 cm-1. Reduction of this absorption by an order of magnitude will greatly improve the usefulness of AgGaS2.

PHASE I: Develop and perform analysis of absorption mechanisms in grown samples of AgGaS2 and ascertain the most effective methods to reduce surface and bulk and absorption in the crystal.

PHASE II: Continue absorption analysis and implement methods to reduce absorption. The contractor shall deliver any software developed, samples of $AgGaS2$ with low absorption, document the work performed, and develop a plan to implement improvements in growing techniques in production growth runs of the crystal.

COMMERCIAL POTENTIAL: The development of the crystal under this program will enable the construction of optical parametric oscillators that will be useful for many civilian applications. These include remote sensing applications, pollution monitoring of industrial plants and waste sites, process monitoring in manufacturing, identification of agricultural and plant species and growth conditions. Medical applications include glucose monitoring, photo dynamic therapy for cancer, tissue cutting, and cauterization. Commercial aviation would also be impacted by allowing the detection of wind shear. In addition, the astronomical community could use the material to construct a source of sodium-resonant radiation, which is useful in compensating for atmospheric distortions.

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AF95-113 TITLE: Robust Suppression Of Noise In Precision Equipment

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a noise control technique that utilizes Robust Control Theory to suppress acoustic noise effects on precision optical system.

DESCRIPTION: Noise effects in enclosures such as airplane compartments can be a significant disturbance to precision optics. It is recognized that passive noise control, such as sound barriers, are not effective at low acoustic frequencies. The reason for this is that low frequency acoustic waves are long with respect to typical sound absorbing barriers. For instance, a 100 Hz sound wave has a wavelength of about 3.4 meters and acoustic materials are typically a few centimeters thick, and cannot trap the sound. Because of this, the field of active control has developed extensively over the last 20 years. The problem of acoustics for the Phillips Laboratory (PL) is to suppress the effects of sound waves on military weapons systems. The PL is developing High Energy Laser (HEL) systems under the Airborne Laser program. Acoustic sources on airplanes are plentiful and originate from engines, air flow over the fuselage, and internal carried equipment. These noise waves couple into precision pointing systems such as that used to direct the laser. In the past, attempts to measure the acoustic environment and correlate it with pointing errors have been largely unsuccessful. The reason is that point measurements, such as a single microphone, only measure noise at one point, and the noise actually couples into the pointing system at many distributed locations. Robust Control Theory has been developed over the past ten years to design control systems that have a large number of inputs, perhaps in the hundreds, and ensure optimal system operation. The PL has successfully applied Robust Control Theory to adaptive optics but has not previously used the theory to suppress acoustic disturbances. This project will utilize the technology of Active Noise Control coupled with Robust Control Theory to demonstrate compensation schemes for distributed noise disturbances.

PHASE I: Join the fields of Active Noise Control and Robust Control Theory to demonstrate via simulation tools that noise can be suppressed. An optical system with four fixed relay mirrors (sensitive to acoustics) and two beam steering mirrors (also sensitive to acoustics) will be simulated. Possibly utilize acoustic suppression with speakers and feed forward commands to the beam steering mirrors to demonstrate the proposed concept.

PHASE II: Design and conduct a laboratory test demonstration with an optical system based on the Phase I design and a large acoustic generator as a disturbance source. Demonstrate that the proposed approach will significantly improve jitter performance of optical relay systems. Invite possible manufacturers of precision machinery susceptible to noise problems to attend the Technical Interchange Meetings (TIMs). Develop a package of speakers, hardware interfaces, and associated hardware that can be advertised outside the DOD community.

COMMERCIAL POTENTIAL: The result should be an attractive commercial product to be advertised to many precision hardware manufacturers. One example would be to remove noise effects from large precision machinery that makes semiconductor circuits. Another possibility would be in the communication industry in reducing noise effects in pointing systems to satellites. An extension of the technology would be to measure vibration inputs to the four wheels on a vehicle and use active noise suppression to quiet the ride.

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AF95-114 TITLE: Spatial Light Modulators For Use In Compensated Imaging Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Technology development for inexpensive, lightweight, reliable wavefront correction devices needed to improve the performance of very high resolution imaging systems.

DESCRIPTION: Adaptive optical systems are used on large earth-based telescopes to measure and compensate for rapidly fluctuating wavefront distortions which blur the images of objects viewed through the turbulent atmosphere. The development and testing of deformable mirror system prototypes designed for use in such systems date back to the early 1970s and continues to the present day. All operational systems to date have been opto-mechanical in design; based upon the concept of a elastic reflecting surface which is rapidly and continuously deformed by a closed loop feedback process involving a wavefront error sensing device and mirror surface control actuators. While many of these systems have been successfully tested and deployed they typically suffer from operational shortcomings associated with weight, fabrication expense and complexibility, reliability, and serviceability. As a consequence, there is a compelling need to evaluate the application of new component technologies capable of improving the operational performance of adaptive optical systems. Recent advancements in the development of spatial light modulators (SLMs) suggest the possibility of replacing opto-mechanical control of wavefront phase with electro-optical control inside of a solid state device. Once successfully adapted for this application such devices offer the prospect of solid state reliability, low weight, low power consumption, and low purchase price based on cost effective manufacturing processes. The Interferometric Imaging Group of the Phillips Laboratories Lasers and Imaging Directorate has already demonstrated the use of an analog Liquid Crystal Display (LCD) as a wavefront compensation device in a recent proof of concept experiment. Future experiments using more advanced digital devices equipped with wavefront sensors will be required to demonstrate adequate spatial control of the aberrated wavefront together with temporal bandwidth adequate to perform the operational mission. Other significant issues to be resolved include achievable optical throughput efficiencies, the achievable stroke of the SLM phasing elements, the tradeoff between stroke and operating bandwidth, appropriate methods of wavefront sampling, and how best to apply the correction signals to the phasing channels of the SLM device.

PHASE I: Design, fabricate and conduct performance tests on a SLM based wavefront correction device in the laboratory. Optimize and document such critical performance parameters as phase correction amplitude and operating bandwidth

in the laboratory environment. Identify a development path for a SLM that will culminate in a level of system performance sufficient for real time wavefront compensation on a ground-based telescope.

PHASE II: Test the SLM device developed in Phase I on a ground-based telescope. Characterize the performance of the device in closed loop adaptive optics operation in the presence of atmospheric turbulence. Demonstrate the high performance SLM device(s) can be produced reliably at a lower cost than competing technologies.

COMMERCIAL POTENTIAL: Unified Space Command (USSPACECOM) uses adaptive optics technology for reconnaissance and surveillance purposes in its high resolution satellite imaging and hyperspectral imaging programs. Other government agencies involved in long range reconnaissance or surveillance activities within the atmosphere will also benefit from the application(s) of such technology. In the scientific sector the astronomical community uses and is interested in expanding the availability of adaptive optics technology in order to enhance basic astronomical research requiring very high resolution imagery of astronomical sources. The development of inexpensive yet high performance wavefront compensation devices and the means to manufacture them such as envisioned in this announcement will create a significant commercial opportunity in satisfying the demand for new imaging technology throughout the worldwide astronomical community.

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AF95-115 TITLE: Real-Time Pattern Recognition Using Compressed Video

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop a real time system capable of complex image (medical or target scene) analysis with IR and visible sensors.

DESCRIPTION: The proposal is to address the problem of feature extraction and image recognition from high data rate image data streams. We wish to explore the concept of analyzing data which has been subjected to image compression, such as JPEG, MPEG, or fractal image compression. The civil applications of such image analysis include biomedical imaging (video lesion analysis, MRI data reduction, PET scan analysis, thermal imaging, and x-ray analysis). An analysis system can aid a medical specialist in identifying and highlighting features of concern; real-time capability would bring this assistance much closer to the patient, and increase throughput. Of particular interest to this laboratory is target discrimination and/or identification of missile targets in either isolated or cluttered target scenes; other military target identification is also of interest.

The algorithm must operate on a compressed data stream (for future scalability to higher data rates) and should be capable of operating on current standard real-time video data. Minimum initial video rates of 512 X 512 RS-170 or digital video at 30 frames/sec and/or smaller focal planes at proportionally higher frame rates. Compatibility with both visible and IR imagery is required. The objective is to identify features in the scene, isolated them, enhance them, and possibly track them. The algorithm should have the ability to compare large numbers of templates versus input images, and be able to cope with image variation in intensity, rotation, translation, and background. Shape-based algorithms are preferred. The algorithms should run on commercially available image and signal processing hardware for speed of development and to minimize costs. The real-time video analysis platforms should also be easily upgradeable for increased computation (both hardware and software). The user needs to be able to interactively analyze the progress of the algorithm and add new templates to the system to examine and compare to a wider class of reference images. For medical and dual-use applications, the system should be self-contained, flexible, and use a standardized high-capability, high-capacity image processing bus so to be adaptable to many input data

sources. For military applications, the system should be adaptable and transportable for use on many kinds of air, space and ground-based platforms.

PHASE I: Proposal of the basic algorithm and a plan for implementation on the real-time video processing hardware as well as comparison with currently accepted pattern recognition techniques. The Phase I option shall include first basic lab validation of technique on real-time hardware.

PHASE II: Field test demonstrating real time performance of algorithm in both a medical clinical setting, and agianst a military target.

COMMERCIAL POTENTIAL: As described above, we are seeking to develop a technique which could deal with the high video data rates implicit in either medical imaging or in military real-time tracking and targeting. We are specifically aware of medical efforts in video lesion analysis, MRI data reduction, PET scan analysis, thermal imaging, and x-ray analysis. Since we are insisting that the effort be based on commercial off-the-shelf video hardware, we expect that advances as part of this program can be readily packaged into commercial products for the medical imaging analysis market. Because we are looking for a method which is compatible with commercial image compression techniques, we expect developments would be easily incorporated into emerging commercial standards for digital medical imaging, and would in fact enhance the functionality of such systems. Fostering such commercial standardization and performance, along with compatibility with similar military needs, would benefit DoD by leading to capabilities which leverage a strong commercial base. We have emphasized the medical imaging commercial market over other commercial markets because of similar needs for very high performance.

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AF95-116 TITLE: Novel Electro-Optic/Chemical Sensors for Hydrazine Vapor/Combustion Product Detection

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop fiber-optic chemical sensors for monitoring hydrazine vapors, or novel electro-optic based detection techniques for measuring propellant combustion products.

DESCRIPTION: Hydrazine fuels are in widespread use as rocket fuels in U.S. space programs. Since hydrazine is highly toxic and a suspected carcinogen, launch personnel must be protected from exposure to hazardous levels. Currently, there is no field operational detector that can monitor hydrazine vapor levels at the 10 ppb, 8-hr time-weighted-average threshold limit values (TLV's) that are expected to become the new exposure standard in the near future. These TLV's are a factor of 10, or more, below present standards. Thus, a significant advance in monitoring technology is needed. Recent progress suggests that a novel approach based on reversible or irreversible colorimetric reagent clad optical fibers may allow real time fuel vapor detection below 10 ppb. Innovative, low cost, reliable methods for manufacturing fiber optic sensors that employ chemical reagents for detecting hydrazine fuel vapors need to be developed. The time and cost for developing new space propulsion engines and advanced energetic propellants could be significantly reduced if the benefits of inexpensive laser based optical diagnostics were available in rugged, flight worthy form. These devices would enable in-situ optimization of fuel mixture ratio, detection of abnormal operation (health monitoring), and monitoring of exhaust pollutants. Rapid advances in electro-optics technology imply that realization of the potential inherent in optical techniques is immanent. For example, visible wavelength diode lasers capable of producing picosecond pulses of GHz repetition rates, and a solid state photo multiplier (PMT) with a 10.6 improvement in

dynamic range over conventional PMT's are currently available. Such advances could allow the combustion characteristics of tiny samples of advanced propellant ingredients to be obtained from a single transient event. Thus, innovative implementation of electro-optic devices of any type are sought, which when coupled with appropriate signal processing strategies, will result in optical spectroscopic hardware applicable to steady state or highly transient combustion product analysis.

PHASE I: Develop a practical method for manufacturing robust reagent clad fiber optic sensors that can detect less than 10 ppb hydrazine vapor, with appropriate operational characteristics (reproducibility, selectivity, response time, dynamic range, shelf life, tolerance to a range of environmental conditions, etc). Or, develop techniques to enable the measurement of combustion products, and toxic or polluting materials in the hostile and transient environment of a rocket engine. Strategies which offer faster response, lower detection limits, smaller size, lower cost and complexity, are of particular interest. In either case, a Phase 1 proof of concept demonstration is required.

PHASE II: Develop and demonstrate a pilot scale process for economically and reproducibly manufacturing very low detection limit hydrazine sensors. Or, develop and demonstrate a prototype of the electro-optic measurement technique explored in Phase 1. In either case, all hardware and software developed shall be delivered, and a well documented plan for technology insertion into Air Force systems and into commercial applications shall be prepared.

COMMERCIAL POTENTIAL: Hydrazine is used by: AFSPACECOM at launch ranges; ACC where fighter aircraft auxiliary power units (APU's) are serviced; the Navy and NASA and industry at rocket launch sites. Hydrazine exposure can also occur at production facilities, industrial users and at waste disposal sites. The SBIR hydrazine sensing technology would be used directly at these locations to limit the exposure of personnel to this dangerous material. By varying the chemical makeup of the optical fiber cladding reagents, this same technology has enormous potential to be widely applied as a sensitive, low cost means of detecting wide ranges of compounds. By cladding fibers with materials that are color sensitive to pressure, temperature, etc. this technique could see broad industrial application in manufacturing process control, as well as in many other applications. Low cost, rugged, electro-optic based measurement techniques could be widely applied throughout DoD to optimize and control, as well as in many other applications. Low cost, rugged, electro-optic based measurement techniques could be widely applied throughout DoD to optimize and control propulsive combustion devices and to monitor their operation and emissions. Similarly, this technology could be applied to automobile, diesel and marine internal combustion engines. Their low cost would also facilitate use in industrial applications for monitoring stack emissions from power plants and chemical manufacturing plants to name only two of an almost unlimited range of possible applications. Another characteristic of some electro-optic devices is the ability to operate on a picosecond time scale. When coupled with appropriate data acquisition approaches, the SBIR methodology could lead to the ability to measure chemical events that are currently too fast to be measured or observed. This type of fundamental knowledge could lead to the development of new highly energetic propellants, new materials, new "designer" molecules for any number of purposes, etc.

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AF95-117 TITLE: Bioremediation of Hydrazine Propellant Spills

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop an environmentally conscious biological remediation process for emergency remediation of hydrazine fuel spills.

DESCRIPTION: Large quantities of the hydrazine family of fuels are annually shipped by the Air Force all over the United States. Since the potential for an accidental spill, although small, is real, a method is needed to accomplish in-situ remediation. Current methods involve either removal of contaminated soils or chemical treatment. Chemical treatment, in general, is unsatisfactory since it generates reaction products which leave the area contaminated. Removal of the contaminated material

simply transfers the problem to another location, and, in the case of a spill involving a body of water, is not a viable option. Bioremediation offer the greatest potential for an economical, safe approach to spill management.

PHASE I: Phase I of this effort entails two paralled efforts: identification of appropriate microorganisms or microorganisms which can be genetically tailored to metabolize the fuels, and designing the necessary application process. A literature search to select appropriate organisms should be undertaken to select those with the highest potential for success in this application for subsequent testing. The application process design must be appropriate to effectively treat spills on dry soils, wetlands, and in waterways.

PHASE II: Conduct a pilot-scale demonstration of the process and equipment developed in Phase I. Testing will be conducted using actual contaminated soils, sands, aggregates, and water from natural sources. Data will be collected to determine the efficiency of the procedure and equipment, required treatment time, and persistence of the selected organisms in the environment after treatment as a minimum.

COMMERCIAL POTENTIAL: The technology developed by this effort is applicable to DoD, NASA and commercial space launch programs as well as other government, academic, and industrial manufacturers and users of hydrazine. It would also provide a significant enhancement in the remediation of contaminated government and commercial facilities. In view of the wide spread commercial uses of hydrazines, this technology has a potentially large, and environmentally significant market.

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AF95-118 TITLE: Space Or Near Space Flight Experiments Demonstration Support

CATEGORY: Basic Research
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop innovative support systems and/or components for space or near space flight experiment demonstration which offer significant improvements over existing support resources.

DESCRIPTION: The Space Experiments Directorate is responsible for the development of a robust infrastructure to support the insertion of new technology into DOD and US space systems. Requirements to validate new technology through demonstration involve a variety of platforms to accomplish space and near space testing (e.g., high altitude balloons, high altitude aircraft, sounding rockets, free flying satellites, and captive space shuttle payloads). Our directorate is interested in innovative developments in the following areas which can demonstrate significant improvements in ease of operation, reduce cost of operation and acquisition, maximize where possible usefulness/synergy between the above platforms and payloads, simplify operation and maintenance, provide high reliability, or enhance data acquisition, coding and recording (non-volatile storage): attitude control subsystems; communication subsystems compatible with existing ground station protocols; electrical power subsystems; structural subsystems; thermal control subsystems; ground station systems; integration and test support equipment; experiment integration development aids (concept to finished product computer-aided development system).

PHASE I: Phase I will address the aforementioned systems and areas through superior design with as much ground work in analysis and test as possible. The proposal will perform engineering analysis necessary to analytically demonstrate the feasibility of the improved capability. Where there are elements that can not be shown feasible through analysis, risk reduction-testing of those elements will be performed in this phase. The proposal clearly addresses the potential platforms supported by the proposed product, the modular scalability of the product, the resulting benefits of the system (should address but is not limited to the above significant improvement issues), and the approach to manufacturing and space qualifying.

PHASE II: This program will construct and comprehensively test prototype products, on the basis of the Phase I analysis and risk-reducing tests.

COMMERCIAL POTENTIAL: Topics in this broad SBIR generally apply to making the use of space systems easier and more routine. All of the advancements solicited are geared to making use of space more inexpensive and reliable, therefore more accessible to a wider range of users including universities and small firms. Further, long-term application of these advancements may lead to space vehicle operations that more closely approximate today's operations with aircraft, without the extreme

investments that currently prevent most of industry from using space as a resource. Further, development of these technologies offers application to a range of industries that may not be directly space related. Attitude control, power, structural and thermal control capabilities are broadly applicable to nearly any kind of autonomous vehicle, regardless of its intended purpose. The remaining technologies are also applicable, to varying but lesser degrees.

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AF95-119 TITLE: Extension Of GPS To Small Rocket Trajectory Determination

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Navigation, Guidance & Vehicle Control

OBJECTIVE: Develop and demonstrate a low cost GPS system to provide location information for small research and meteorological rockets.

DESCRIPTION: Small rockets have been used for years to determine meteorological information and other data for scientists investigating the aerospace environment. Recently the rockets have been used to measure the electric field in thunderstorms to determine the critical field strength required to initiate lightning strikes. The research is often performed in areas that do not have sufficient radar or other instrumentation coverage for an accurate determination of the rocket trajectory. Inclusion of sufficient on-board inertial navigation instrumentation for this determination would be too expensive. Recent advances in small, low cost, GPS systems for use on balloons has suggested that GPS might be useful for these small rockets as well. Position and velocity would not necessarily be required in real time, but could be deduced by post flight data analysis.

PHASE I: Produce the conceptual design for a small GPS systems for small rockets including weight, volume, and power requirements, trade-offs for on-board versus ground station computational requirements, probable accuracy for the various portions of the trajectory, implications of adverse environmental conditions, and concepts for inclusion of location data into the telemetry stream.

PHASE II: Design and produce a prototype of the system, including on-board and ground station components. The prototype will be flown on a 2.75" FFAR rocket on a range with radar coverage as proof of concept. During this design the contractor shall determine trade-offs towards a configuration which achieves low cost for the on-board portion of the system. The rocket will be launched by an Air Force team at a government launch facility.

COMMERCIAL POTENTIAL: If the concept can be demonstrated and lives up to the low cost promise, it can have wide use on DoD, NASA, and other government scientific sounding rocket and meteorological programs. The GPS system itself has been heavily commercialized. Any extension of capability into low cost uses of the system for the acquisition of velocity, location, and any other data will surely have high commercialization potential.

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Pardo, M. "Characterization of the Clock in a New Inexpensive GPS Receiver: The Magnavox MX4200." Naval Postgraduate School, Monterey, CA, Sep 91. (available from DTIC as AD A246 165).

AF95-120 TITLE: Composite Mission Simulator

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop a composite mission simulator for real-time interactive electronic combat evaluations.

DESCRIPTION: Current electronic combat composite mission simulators operate with low to medium fidelity and with limited players in order to achieve real-time operation required for interactive man/hardware-in-the-loop evaluations. As an example, the Integrated Defensive Avionics Laboratory (IDAL) utilizes the Tactics and Engagement Evaluator (TEEVAL) for the composite mission simulator. TEEVAL is SUPPRESSOR, a mission level simulation, with a software shell that allows external control of the penetrator by the Crew/Vehicle Interface and extraction of the engagement event data for the environment and threat simulators to stimulate/interact with the electronic combat hardware. This topic requires innovative research to define/develop a composite mission simulator that can accommodate the total number of players in a realistic threat scenario, provide on-line model fidelity management and easily be modified/upgraded for future requirement.

PHASE I: Define the key technical requirements/issues, develop a preliminary design and provide an implementation approach with an analysis of feasibility and cost/fidelity trade-offs. Performance demonstrations of critical aspects of the design are desired to evaluate risk in proceeding with Phase II.

PHASE II: Develop, fabricate, demonstrate, evaluate, and document the proposed design.

COMMERCIAL POTENTIAL: This SBIR topic has dual use potential for the real-time modeling of complex processes. The basic system and architecture can be utilized for commercial design processes to reduce modeling time and increase modeling efficiency. This could result in substantial development cost savings for efforts such as communication networks that require complex real-time modeling and simulation. The results of this effort can also be readily applied to the rapidly evolving/expanding interactive computer game industry. This technology will enable the game industry to make the implementation of high fidelity virtual reality affordable.

AF95-121 TITLE: High Fidelity Low Noise Dense RF Radar Threat Environment Simulator

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop a capability to evaluate very high sensitivity RF sensor technology in realistic threat environments

DESCRIPTION: Current electronic combat simulators for evaluating radar warning receivers in realistic dense environments do not provide adequate capability for the next generation very high sensitivity receiver technology. Additionally man/hardware-in-the-loop facilities such as the Integrated Defensive Avionics Laboratory (IDAL) have requirements to operate the aircraft electronic warfare systems all at the same time. This topic requires innovative research to define/develop a high fidelity low noise dense RF radar threat environment simulator capable of evaluating the next generation of electronic warfare (EW) and electronic support measures (ESM) receivers. The research should address the RF architecture to provide a realistic dense signal environment (includes overlapping pulses, high duty cycle emitters, inter/intra-pulse modulations, etc. with minimum pulse dropout), dynamic power outage range from -110 dBm to 0 dBm, frequency coverage from 0.5 GHz to 18 GHz and 24 antenna port outputs. The research should emphasize the requirement for as low a noise floor as possible. The research should also address the application of this simulator to phase interferometer direction finding receivers with up to eight antennas with four elements each.

PHASE I: Define the key technical requirements/issues, develop a preliminary design, and provide an implementation approach with an analysis of feasibility and cost/fidelity trade-offs. Performance demonstrations of critical aspects of this design are desired to evaluate risk in proceeding with Phase II. Phase I proposal should provide the basic RF architecture with sufficient analysis and detail to support his predicted performance. The proposal should address in detail the risk areas and technology limited performance.

PHASE II: Develop, fabricate, demonstrate, evaluate and document the proposed design.

COMMERCIAL POTENTIAL: This SBIR topic has dual use potential for the development of very high sensitivity receivers for space satellite applications. This type of simulator can significantly reduce integration costs providing realistic RF

environments for developing/evaluating the receiver technology. This has application to both the commercial communication and television industries that utilize satellite systems. Currently, these are developed through multiple prototyping of the receivers. The environment simulation technology from this effort would be used by commercial receiver companies to reduce their development costs. Similar simulation technology for developing radar warning receivers has resulted in the establishment of multiple small businesses for developing/manufacturing that technology. The technology resulting from this effort would open similar opportunities for small businesses to support commercial receiver companies.

AF95-122 TITLE: Innovative Interferometric Signal Processing for Laser Warning Threat Identification

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop innovative interferometric signal processing techniques for laser threat parameterization in laser warning/countermeasures receivers

DESCRIPTION: Laser-guided and laser-assisted weapons are diverse and widely proliferated and therefore pose a real and serious threat to USAF fighter aircraft. As the base of laser systems expands, full parameterization of the laser threat signal becomes a critical element of a robust threat table for both situational awareness and countermeasures direction. Several laser wavelengths, multiple pulse encodings, and temporal bandpasses are currently in use, and the technology currently exists to support a large variety of others. An effective laser detection system needs to characterize the source coherence, wavelength, direction of arrival, and temporal pulse characteristics. In addition, the ideal system will have low false alarm rates, high probability of detection, and a wide field of view. There are several single aperture stationary interferometric techniques which are promising for this level of parameterization; however, the signal processing loads for these technologies are significant. New real-time methods to process interferometric data to derive the given parameters are sought. Generic approaches to processing interferometric data or signal processing techniques tailored to specific, novel interferometric concepts may be considered. Both optical and electronic processing may be appropriate for this effort. The same parameterization techniques may also be applied to a variety of commercial applications including spectrochemical detection and monitoring of hazardous wastes at remote sites.

PHASE I: This program should generate signal processing techniques for existing interferometric concepts as well as novel combined interferometer/signal processing concepts capable of laser threat parameterization as discussed above.

PHASE II: A brassboard sensor will be designed, fabricated, and delivered. Detailed laboratory performance measurements will be made. Field support will be supplied for subsequent government field and possible flight tests. An advanced development demonstration of a successful Phase II receiver will be accomplished.

COMMERCIAL POTENTIAL: This SBIR topic has dual use potential in spectrochemical diagnostics for hazardous chemical detection and analysis. The technology can also be used for environmental monitoring, medical diagnostics, process control and remote sensing.

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AF95-123 TITLE: Standard Multispectral Environment Representations within Software Structural Model (SSM) Framework

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computers

OBJECTIVE: Research and develop standard multispectral environment representations within an SSM-based framework.

DESCRIPTION: The objective of this research is to research and develop a standard multispectral environment representation within an SSM-based framework, currently J-MASS. This includes investigations into Radio Frequency (RF), InfraRed (IR), Electro-Optical (EO), Acoustic, Sonar, Digital Terrain, geographically-sensitive atmospherics, and other environmental phenomenology. There are many DOD based standardization efforts, including but not limited to Project 2851 (standardizing terrain representations for DOD), Environmental Effects for Distributed Interactive Simulations (E2DIS), Defense Mapping Agency (DMA) products, Common Mapping System (CMS) toolkit. The emphasis on this research is NOT a duplicative redevelopment of these efforts, but rather a synergistic integration of these efforts into a standard structural model object based framework, currently the J-MASS. As part of all three phases of this effort, the appropriate government and commercial organizations should be consulted.

PHASE I: The desired product of the Phase I effort is an identification and prioritization of all DOD/Federal/Commercial multispectral environment efforts. The prioritization will be based upon J-MASS user needs and requirements. Standard representation message formats should be recommended (e.g. Standard IR or RF signal packet). A prototype integration of at least one aspect of the standard multispectral environment is desired.

PHASE II: The desired product(s) of the Phase II effort is the integration and implementation of prioritized standard multispectral capabilities within the SSM framework, currently J-MASS. In completing Phase II, J-MASS or its successor should have a "complete" set of multispectral representations (i.e. each aspect of multispectral environment representations should exist to some extent). The message format standards for each aspect of the multispectral should be documented. Simulation objects which exercise the multispectral aspects should be developed and tested. Maximum reuse of existing simulation objects is paramount in the development and testing.

COMMERCIAL POTENTIAL: Every model or simulation built using current technology must "reinvent" multispectral representations. Often, these are buried in the algorithm of the objects exercising the environment; J-MASS is an effort whereby the "domain expert" contributes their "piece" of the simulation pie. The current lack of standard environmental representations severely limits verification and validation efforts of given simulations. The desired product(s) of this effort, in addition to the commercialization of the multispectral capabilities, is a complete set of multispectral capabilities at various levels of simulation granularity (resolution). This effort builds upon Phases I and II, and now for each aspect of the multispectral environment, multiple levels of simulation resolution should be supported. This potentially requires several representations and/or message formats for each level of resolution required, but ALL representations and message formats should conform to a standard for that resolution, identified in Phases I and II. Simulation objects which exercise the multispectral aspects at each level of resolution should be developed and tested. In the development of these test objects, maximum reuse of existing simulation objects is paramount. The results of this research could significantly improve both DOD and commercial simulations requiring multispectral environment representations.

AF95-124 TITLE: Non-intrusive Electronic Combat Environmental Effects Instrumentation

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop nonintrusive instrumentation capability for determining electronic combat environmental effects on electronic warfare (EW) systems.

DESCRIPTION: Current EW man/hardware-in-the-loop simulator capabilities such as the Integrated Defensive Avionics Laboratory (IDAL) are able to generate real-time electronic combat environmental effects but have difficulty extracting the resulting effects on the EW system without affecting that system's operation. This topic requires innovative research to define/develop a nonintrusive capability to extract the effects data from the EW system. This nonintrusive extraction process must be able to produce data with sufficient fidelity to support emulative type models.

PHASE I: Define the key technical requirements/issues, develop a preliminary design and provide an implementation approach with an analysis of feasibility and cost/fidelity trade-offs. Performance demonstrations of critical aspects of the design are desired to evaluate risk in processing with Phase II.

PHASE II: Develop, fabricate, demonstrate, evaluate, and document the proposed design.

COMMERCIAL POTENTIAL: This SBIR topic has dual use potential for real-time instrumentation. The basic system and architecture can be used for instrumentation of complex industrial processes or inflight aircraft avionics. The automotive industry has a need for this type of instrumentation system to develop a single serial data bus for control/monitoring of all on-board sensors and control systems (safety systems, environmental control systems, engine performance control, etc). Additionally, nonintrusive instrumentation is a requirement in the rapidly evolving microprocessor industry. High fidelity nonintrusive instrumentation can be readily be marketed in the commercial airline (Boeing, McDonald-Douglas, Cessna, Lear, Beach, etc), and microprocessor (Intel, Motorola, AMD, etc.) industries.

AF95-125 TITLE: Advanced Electro-Optical Sensor Development and Test

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop innovative, high performance sensor designs and test and evaluation capabilities for sensor systems.

DESCRIPTION: Electro-optical sensors have demonstrated significant military capability because of their ability to perform imaging, tracking,and targeting functions. Emerging electro-optical sensors must be able to operate under a broad range of airborne environmental and operational conditions while simultaneously displaying increased operating range, increased use of spatial and spectral information, increased reliability, lower cost, and decreased size and weight from currently available sensors. Both the development of sensors with these attributes and the development of capabilities to test such sensors under simulated operational conditions is of interest. Specific examples of areas of interest include eye-safe, diode-pumped, solid-state laser sources with high range and cross-range resolution; detector arrays for active as well as passive sensors; nonmechanical agile beam steering for passive as well as active sensors; and test evaluation concepts for enhanced electro-optical sensor and sensor suites which can include infrared, laser radar, and multispectral sensors.

PHASE I: Perform sensor and/or testing concept definition and feasibility analysis. The performance of a sensor or testing concept will be quantified. The output of Phase I will be the design of the concept and a development plan. It is anticipated that concepts for testing advanced electro-optical sensors will be implemented in the Air Force Sensor Evaluation Center (AFSEC) in the following phase. The AFSEC is a unique facility that can test sensor systems under simulated flight conditions.

PHASE II: Sensor concepts will be implemented in hardware and feasibility demonstrations will be accomplished. Testing concepts will be implemented in AFSEC and demonstrated.

COMMERCIAL POTENTIAL: It is anticipated that this topic will produce advanced remote sensing capabilities that will be applicable to a variety of uses in electronic imaging and machine vision, i.e., automatic, machine processing.

REFERENCES:
Air Force Evaluation Center (AFSEC) Capabilities and Facilities Brochure.

AF95-126 TITLE: Electronic Protection Technology: Military and Non-military Applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop software for enhancing Electronic Protection (EP) Technologies for Military and Civilian applications.

DESCRIPTION: EP techniques are designed to address specific jammer Electronic Countermeasure (ECM) interference conditions. This approach to technique development and implementation is not necessarily optimal for system effectiveness and may not address unintentional interference. It is anticipated that more RF interference will be encountered in the future as greater numbers of technological diverse systems attempt to use an already crowded RF spectrum. The RF interference could be fueled by greater amounts of sophisticated military ECM equipment appearing on the surplus market. A program to address specific weaknesses in the implementation of military EP technologies must be attuned to the military and civilian marketplace. For example, cost has been a critical issue with the civilian sector and now must be addressed with both military and civilian applications in mind. Normally, interference problems are not addressed until they are too costly and then there is a time lag in finding, selecting, and implementing an appropriate solution. What industries need are off-the-shelf technological solutions to projected future interference problems.

PHASE I: Define an approach and identify potential solutions to negate the effects of the in-band electromagnetic interference on radar systems. Define a decision logic network to respond to interference (intentional and unintentional) signals by implementing off-the-shelf EP techniques. Investigate and develop a methodology for accessing off-the-shelf military EP technology for civilian entities including: a review of military and nonmilitary interference problems encountered, the fixes made and the lead time required; projections of future interference environments based upon the types and numbers of new (potential) interference sources added to what is there now; and identification of the promising approaches and technologies which can be used to solve such military and nonmilitary problems. Identify simulation tools to support this radar investigation.

PHASE II: The Phase I effort will be developed into an EP technology identification and selection methodology including an associated database that would allow a military and civilian user to enter the methodology with specifically defined interference problems and receive a set of recommended fixes based upon available EP technology. Specific system solutions will be addressed to include internal interference and appropriate results entered into the data base.

COMMERCIAL POTENTIAL: This SBIR software product will have phenomenal Phase III business potential with international and domestic airlines, avionics companies, the Coast Guard, the Federal Aviation Administration, and the Drug Law Enforcement Agencies. In addition, designers, developers and operators of military aeronautical, electronic warfare, EP, and sensor systems will benefit.

REFERENCES:
Morris, Guy V., "Airborne Pulsed Doppler Radar," Artech House, Norwood, MA, 1988.

Rhodes, D. R., "Introduction to Monopulse," Artech House, Dedham, MA, 1980.

AF95-127 TITLE: Multispectral Fusion Techniques

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop geometry-based multispectral fusion identification algorithm techniques.

DESCRIPTION: The Air Force uses radar and forward-looking infrared (FLIR) systems to perform air superiority, interdirection, and reconnaissance missions. Desert Storm experience suggests that strategic targets will employ Camouflage, Concealment & Deception (CC&D) to avoid detection. To overcome this difficulty, synergy among the sensors must be exploited. The Air Force wishes to demonstrate cueing a FLIR sensor with radar detections and investigate the utility of new or improved sensors. Radio frequency and electro-optic sensors are different, but each observes the same target geometry and material properties. This project examines fusion of sensor information through reference to a single geometric description of the target. Resource Allocation and Directed Vision will develop detection prioritization methodologies associated with decision level fusion. Fusion for ATR will develop feature level fusion and the capability to hypothesize and test across phenomenologies. This will require Multisensor Simulation in Khoros, which includes construction of Defense Mapping Agency (DMA) derived representative backgrounds for registered thermal, laser radar, and SAR data in the Khoros/Cantata computing environment and may include: methods to degrade high quality data to simulate realistic sensors and conditions; uncertainty based (statistical/stochastic) prediction of FLIR target signatures; and improvements to SAR signature prediction capabilities.

PHASE I: Demonstrate decision level fusion of representative algorithm output to quantify performance benefits of additional sensor information. Identify target-based features appropriate for feature level fusion.

PHASE II: Develop decision level fusion techniques for selected ATR algorithms. Develop feature level fusion techniques and the capability to hypothesize and test across phenomenologies.

COMMERCIAL POTENTIAL: Medical imagery such as Magnetic Resonance Imagery (MRI) and Computer Tomography (CT) are related image forms to SAR. They both are used as preoperative analysis and planning imagery but for most soft tissue surgery are only valuable as reference information. This SBIR's Multisensor fusion of real-time imagery such as ultrasound with the preoperative MRI or CT would provide the surgeon with a non-invasive three dimensional imagery set for use during a surgical procedure.

REFERENCES:
Rosenfeld, Azriel (ed), "Multiresolution Image Processing and Analysis," Springer-Verlag, 1984.

Blackman, Samuel, "Multiple Target Tracking with Radar Applications," Artech House, Norwood, MA, 1986.

AF95-128 TITLE: Pattern Theory Extensions and Applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computers

OBJECTIVE: Apply pattern theory robust pattern finding capability to solve information processing problems.

DESCRIPTION: Pattern theory is an established paradigm which provides a robust characterization of patterns. "Robust" is used in the sense that patterns of all types are included, for example numeric patterns, symbolic patterns, string-based patterns, and patterns in images. Recent research provides strong theoretical and empirical evidence that Decomposed Function Cardinality (DFC) provides a robust basis for pattern finding. Applications of DFC-based pattern finding are possible in many areas. However, application development has been hampered because current algorithms are limited to binary functions with a limited number of input variables and a single output variable. The goals of Phase I are to 1)identify innovative applications, and 2)

determine the technical merit and feasibility of pattern finding algorithms to meet the requirements of these applications. These applications may require extensions to the current pattern finding algorithms. Examples of such extensions are 1) provisions for multiple output variables, a larger number of inputs or multiple-valued input and output variables, 2) a treatment of objects that are not functions, or 3) the exploitation of prior knowledge about the pattern.

PHASE I: Define approaches to developing any extensions necessary for the identified applications.

PHASE II: Develop the extensions identified in Phase I and demonstrate the resulting product in a specific application. The products of Phase II will include any extensions to the pattern finding algorithms, a demonstration of the extended algorithms in a specific application, and an identification of high payoff areas for further pattern theory extensions.

COMMERCIAL POTENTIAL: There are two routes that could be pursued for dual use commercialization. One route is to develop a general purpose software product that would address the need for more robust solutions in the rapidly growing market for computational learning packages. A second route is to use the Phase II results in a specific commercial application, such as logic minimization, computational learning, image processing, or data compression; any of which has excellent dual use potential.

REFERENCES:
"Pattern Theory: An Engineering Paradigm for Algorithm Design," WL-TR-91-1060, DTIC AD-A243214.

"Pattern Theoretic Image Restoration" SPIE'93 Nonlinear Image Processing, Jan 93.

"Pattern Theory in Algorithm Design" NAECON Proceedings, May 93.

"A Demonstration of a Robust Occam-Based Learner," IEEE International Symposium on Information Theory, 1993.

AF95-129 TITLE: Innovative Airborne Detection and Tracking Concepts

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop innovative sensor and processing concepts to perform airborne multitarget detection and tracking.

DESCRIPTION: Early detection of potentially hostile air vehicles is critical to situational awareness and effective fire control. Tactical targets, however, are becoming increasingly elusive due to small physical size, high maneuverability, low-altitude operation, and stealth technology. The objective of this effort is to develop both sensor and processing concepts to improve our current capability to detect and track these airborne targets. Processing concepts to consider include, but are not limited to, multihypothesis tracking, multiresolution filtering, track-before-detect, queued sensors, wavelet transforms, passive ranging, and sensor fusion. Concepts may rely on any sensor or combination of sensors which can be hosted on one or more manned tactical aircraft. Sensors to consider include, but are not limited to, infrared search and track, ultraviolet search and track, passive and active Doppler radar, electronically scanned antenna radar, synthetic aperture radar, inverse synthetic aperture radar, ultrawideband radar, laser radar and continuous wave radar. Modifications to these sensors, such as lowering detection thresholds or updating analog-to-digital converters, should be considered as should multiaircraft approaches.

PHASE I: Develop and evaluate their proposed technique to establish technical feasibility and operational utility.

PHASE II: Implement the selected approach(es) and perform a detailed analysis of the proposed design. High payoff concepts will be identified.

COMMERCIAL POTENTIAL: Airborne surveillance radars are required for such dual-use applications as civil air traffic control and law enforcement. The basic technological innovations associated with long-range detection and tracking, however, have many more applications and opportunities for dual use are virtually boundless. For example, signal processing techniques such as data windowing, wavelet transforms, and multiple hypothesis generation are candidate approaches for this SBIR proposal. They are also being applied in such diverse fields as image processing, digital communications, speech recognitions, industrial automation, and simulation. Advancements in any of these basic techniques as applied to multi-target tracking could lead to significant new capabilities in multiple fields. The fundamental challenge in long-range detection and tracking is to extract all the information present in an in-coming signal, an almost universal theme in electrical engineering. A significant advancement in long-range tracking could have far-reaching ramifications for any system using electronic signals.

REFERENCES:
Friedlander, B. and Porat, B., "Performance Analysis of Multiframe Detection Algorithms, Phase 1, BMO Report # SAXPY-TM-1000-01, DTIC #B112322.

Polge, R.A., "Adaptive Tracking of Cruise Missiles by One or Several Radars Using Advanced Sensor Fusion Techniques," DTIC #DA337077.

AF95-130 TITLE: Avionics Wind Tunnel Concept

CATEGORY: Basic Research
DOD TECHNOLOGIES: Communications Networking

OBJECTIVE: Develop and demonstrate the technologies to support networked simulations used for real-time avionics system testing.

DESCRIPTION: The Avionics Wind Tunnel concept is being implemented at the Avionics Directorate to perform research and evaluation of advanced integrated avionics systems, off-board and on-board sensors, and associated subsystem technologies through development of real-time interfaces and networks between distributed research facilities. This innovative concept involves placing the advanced avionic hardware and software technologies into a realistic testing environment. These signal and threat environments will be generated, controlled, and coordinated through pilot-in-the-loop interaction with a high level engagement model. The engagement model will simulate a combat environment threat complete with reactive threats and friendly forces providing communications, jamming, radars, and countermeasures. The event data and platform movements will be used by distributed simulators placed around a high bandwidth network which produce a realistic environment to evaluate avionics equipment and sensor and data fusion technologies. This topic area requires innovative research to define, develop, and demonstrate modeling, simulation, and networking technologies to meet the future research, development, and testing requirements of integrated avionics systems.

PHASE I: Define the key technical requirements and issues, and develop a system specification, implementation approach, and demonstration plan.

PHASE II: Accomplish a detailed design, develop the prototype technology and demonstrate the proposed technology as part of the Wright Laboratory Avionics Wind Tunnel complex of distributed simulation facilities.

COMMERCIAL POTENTIAL: This effort has dual use potential for the real-time modeling and simulation testing community. The advancement and use of computer systems and high bandwidth networking will have a tremendous effect on the commercial efforts in medium and long haul networking. This effort will result in substantial cost savings for future users, commercial products, and efficient simulation integration.

REFERENCES:
Howell, D.L., "Integrated Laboratory: Real-Time Interactive Communications Simulation," NAECON 90, 21 May 1990.

Woodyard, J., AWT-IDD-01, "Interface Design Document for the Avionics Wind Tunnel Capability Demonstration," May 1992.

Ganote, T. and Harris, L.M., "Generic Interface (VMS Version) to the Real-Time Simulation Network for the Avionics Wind Tunnel," January 1993.

Howell, D.L., Woodyard, J., and Wiseman, J., "Avionics Wind Tunnel: Laboratory Interface Development," NAECON 93, 24 May 1993.

AF95-131 TITLE: Avionics Applications of Reinforcement Learning Systems

CATEGORY: Basic Research
DOD TECHNOLOGIES: Computers

OBJECTIVE: Apply reinforcement learning systems to the solution of problems in avionics.

DESCRIPTION: Identify an avionics problem or problems, such as sensor management, sensor fusion, fault detection and diagnosis, or communications, that might be solved by a nonlinear optimal control system that learns to improve performance with experience (a reinforcement learning system). A problem suitable for reinforcement learning typically can be described as an optimal control problem, where a controller learns to follow an optimal trajectory through state space, and where the optimal trajectory is not known a priori. Apply a reinforcement learning system such as Advantage Updating or the Associative Control Process (ACP) network to the solution of this problem. Determine the scientific and technical feasibility of this approach, through analysis and simulation. Identify the possibilities of this approach for dual use application to civilian problems.

PHASE I: Determine the scientific or technical merit and feasibility of the application of reinforcement learning to avionics problems.

PHASE II: Produce a deliverable product for use in Air Force avionics consisting of the algorithm developed, all experiments, and analysis.

COMMERCIAL POTENTIAL: The systems developed will be applicable to avionics problems in civilian aviation, and may be applicable to other optimal control and decision-making problems such as sensor management in automobiles or factories.

REFERENCES:

Baird, L.C.(1994). Advantage Updating. WL-TR-93-1146 (available from DTIC).

Baird, L.C., & Klopf, A.H.(1994). Reinforcement Learning with High-Dimensional, Continuous Actions. WL-TR-90-1147 (available from DTIC).

Baire, L.C., & Klopf, A.H.(1993). A Hierarchical Network of Provably Optimal Learning Control Systems: Extensions of the Associative Control Process (ACP) Network. Adaptive Behavior.1(3), pp. 321-352.

Klopf, A.H., Morgan, J.S., & Weaver, S.E.(1993). A hierarchical network of control systems that learn: Modeling nervous system function during classical and instrumental conditioning. Adaptive Behavior. 1(3)pp. 263-319.

Morgan, J.S., Patterson, E.C. & Klopf, A.H.(1990). A drive-reinforcement model of simple instrumental conditioning. Proceedings of the International Joint Conference on Neural Networks, Vol. 2, 227-232.

AF95-132 TITLE: <u>Environmental Radio Frequency Background Noise Stationarity Measurements and Analysis</u>

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a stabilized radiometer, measure noise stationarity, and derive radiometer sensitivity as function of stationarity.

DESCRIPTION: Numerous low probability of intercept/detection (LPI/D) spread spectrum communication and radar systems are currently under development in the Air Force. Wide bandwidth radiometers are often used to detect signals emitted from these systems. The sensitivity of these radiometers is limited by the stationarity of the background noise environment and the stability of the radiometer circuitry. The amplitude of the environmental noise decreases with increasing frequency and varies considerably with location. The average level of this noise power in the United States can be more than 16 decibels higher in urban than in suburban areas. In remote rural locations, the level may be 15 decibels below that experienced in a typical suburban site. The most important sources of this noise are atmospheric noise, galactic noise, man-made noise, and receiver noise. The stationarity of this noise varies as a function of the following radiometer parameters: center frequency; bandwidth; integration time; time of day; date; and antenna pattern, altitude, and location.

PHASE I: Design a stabilized radiometer for measuring the stationarity of the noise environment at UHF, L-band and C-band (i.e., center frequency equals 316 MHz, 1 GHz and 3.16 GHz). The radiometer shall have five selective input bandwidths for each frequency band (i.e., 0.316%, 1%, 3.16%, 10%, and 31.6%) and 11 selective integration times (i.e., 0.01, 0.0316, 0.1, 0.316, 1.0, 3.16, 10.0, 31.6, 100.0, 316, 1000.0 milliseconds). Develop a test for acquiring and analyzing the environmental noise measurement data.

PHASE II: Develop and test the stabilized radiometer designed in Phase I. The contractor shall select a set of test sites, measure the stationarity of the environmental noise as a function of the above radiometer parameters, and compute the theoretical radiometer sensitivity as a function of these parameters. Develop an equation to theoretically calculate the radiometer sensitivity (i.e., minimum measurable radiometer input signal-to-noise ratio) as a function of the above radiometer parameters.

COMMERCIAL POTENTIAL: This environmental noise measurement and analysis capability will be used for the next generation of government and commercial transceiver development which requires more efficient use of our limited frequency resources. This capability can be used to optimize the section of transceiver system design parameters (e.g., transmitter output power, operating frequency, and bandwidth). It can be used to predict the vulnerability/suspectibility of LPI/D communication systems to detection by a stabilized radiometer. Potential users are the FBI, President's Secret Service, Drug Enforcement Agencies, and city and state police departments.

REFERENCES:

Reference Data for Radio Engineers, Howard W. Sams & Co., Inc., A Subsidiary of the International Telephone and Telegraph Corporation, Sixth Edition, Page 29-3, Radio Noise and Interference.

AF95-133 TITLE: Farsighted Approaches for Sensor Management (FASM)

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: To further develop theoretical foundations for optimal, distributed sensor management.

DESCRIPTION: Sensor management for fighter aircraft is becoming an increasingly complex problem as flexible, sophisticated sensors proliferate, and the dynamic nature of the battlefield continues to intensify. Automating the routine tasks associated with sensor management helps to improve situation awareness and reduce pilot workload, ultimately increasing mission effectiveness and survival. Preliminary research into the intelligent management of distributed sensor assets has revealed several challenges which are worthy of further study and summarized below. These include the study of nonmyopic prioritization and planning, the investigation of scheduling issues, and the development and extension of theoretical techniques to accommodate the multiplatform sensor management problem. Submitted proposals can address all of these challenges or any subset; comprehensive treatments will not be favored over high-quality proposals addressing a specific challenge(s). The first challenge is to devise methods for sensor allocation that account for the evolution of the mission through time. Previous attempts to design sensor managers have been largely myopic, i.e., focused on the near-term aspects of the prioritization problem, usually looking just one step ahead. Such managers fail to anticipate the inevitable changes adequately. Issues that must be addressed in this challenge include a highly uncertain environment that contains both natural and manmade variations; times when sensor demand exceeds capacity; a very dynamic situation where the threat configuration, the mission goals, and the pilot's actions may change rapidly; enormous complexity arising out of the mix of interrelated random variables, decisions, and outcomes; the potential for high computational loads based on large state sizes and modeling difficulties; conflicting objectives such as the need to remain covert but still know the situation precisely; and wide differences in sensor abilities, controls, and limitations.The second challenge involves sensor scheduling, where sensor requests from prioritization are forged into a detailed sensor sequencing plan. Several difficulties arise: multiple tasks may contend for the same resource; ongoing tasks may need to be suspended, terminated, or relocated; tasks may have hard or soft deadlines; tasks may or may not be interruptable; and tasks may be of uncertain duration. While a task is waiting, environmental conditions or objectives may change, rendering it suddenly necessary or unnecessary. Unfortunately, the task prioritization and resource scheduling problems are generally treated separately in the theory. This effort would integrate scheduling considerations into the overall decision process. For example, this would include optimal resolution of task collisions, adaptive adjustment of planning horizons, and a high degree of responsiveness to very dynamic situations.The final challenge is to manage a distributed network of sensors across cooperating platforms. This may require the development or adaptation of theoretical techniques. The issues involved include distributed resource controls across aircraft, coordination of functions, and alignment considerations. In order to synchronize activities, resources such as the high accuracy clock signals from GPS may be used. One major function of the sensor manager is to supply useful data to the pilot; therefore, issues such as data latency, communications burden, and data accuracy will be investigated.

PHASE I: Develop sensor management technology to solve all or some of these diverse issues.

PHASE II: Phase II will further develop the candidate techniques. This phase will then design, utilize, and test these techniques through simulation.

COMMERCIAL POTENTIAL: The manufacturing industry may will use the resource allocation methods in production planning and scheduling. These technologies are especially useful in manufacturing for automated multistep processes which use sensors to determine positioning, defects, and other factors. Resource allocation problems for R&D projects having multiple, competing objectives in an uncertain environment is another dual use for this technology. Other non-traditional use for these defense technologies are the automobile industry, underwater exploration and mining, space exploration, and robotics. The automotive industry is an especially attractive dual use for this technology. This is because the automobile manufacturers are being pushed to develop sensor management technologies with new car developments such as computer controls, GPS, onboard maps, and other intelligent features. Also, the technologies for sensor allocation and scheduling, and information sharing across multiple platforms will be a critical item for the Intelligent Vehicle Highway System being developed.

REFERENCES:

Musick, S. and Malhotra, R. (1994) "Chasing the Elusive Sensor Manager," Proceedings of NAECON, May 1994, Dayton Ohio.

Tesauro, G. (1992) "Practical Issues in Temporal Difference Learning," Machine Learning, 8(3):257-277.

Watkins, CJCH and Dayan, P. (1992) "Q-Learning," Machine Learning, 8(3):279-292.

Multiplatform Resource Sharing CRDA Report, W. Bryan Bell, Advanced Mission Concepts, Lockheed - Fort Worth Companth.

AF95-134 TITLE: Fusion of Avionic Sensor Information into a Geometric Vector with Global Positioning System (GPS)

CATEGORY: Basic Research
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop geometric vector that is updated by all the avionics sensors that provide geometric information.

DESCRIPTION: Most aircraft avionics sensors provide measurements that contain some kind of geometric information. For example, Inertial Navigation System (INS) and Global Positioning System (GPS) provide a navigation solution, radar provides relative target location, and electronic combat sensors provide relative threat location. Typically, this information is gathered, processed and analyzed only by the operationally responsible mission suite of the sensor. Thus, useful information is not being shared among sensor suites. Providing a means to make this information available to all mission suites could improve the desired solutions of avionic suites, reduce costs (removal of redundant sensors and/or reduce specifications of some sensors), improve target tracking, reduce GPS jamming susceptibility, improve in-air alignments, speed up weapon GPS receiver code lock, and many other tasks. A solution to this problem is to create a geometric vector (GV) and update this GV with the raw measurements from the avionic sensors. The GV is a ten-element vector consisting of three position variables, three velocity variables, three attitude variables, and one time variable. This GV can be used as an absolute or relative reference. An example of an absolute geometric vector might be the position, velocity, and attitude of a vehicle with respect to the earth's surface plus Greenwich Meridian Time, and with the basis of the GV being an INS and GPS while measurement from other sensors are applied when available and necessary. When two systems, each represented by a GV, operate relative to each other, a relative geometric vector (RGV) can be formed by subtracting the two GVs. As stated above, most avionic sensors provide geometric information and thus provide measurements that contain some or all of the elements of GV or RGV.

PHASE I: The contractor shall investigate how a GV will contribute and benefit various military aircraft missions. Also, the contractor shall investigate how measurements from a given list of avionic sensors improve the accuracy and robustness of the GV.

PHASE II: Develop the necessary models for the sensors examined in Phase I. Develop a simulation that implements a GV based on the sensor models to demonstrate how a GV contributes and benefits various military missions particularly in accuracy and robustness. Also, determine under what conditions that particular sensor information should be included to update the GV.

COMMERCIAL POTENTIAL: The development of a geometric vector will be useful in commercial aviation particularly for precision landing and in the development of tracking and navigation methods for land vehicles which will be useful for automotive and trucking industries in the tracking of vehicles. The geometric vector may also be useful in autonomous navigation.

REFERENCES:
Lewantowicz, Z. and Paschall, R., "Deep Integration of GPS, INS, SAR, and other Sensor Information," To be published as an invited paper to AGARDograph: "Aerospace Navigation Systems."

Section III: "Analysis and Synthesis Methods." Contact Wright Laboratory/AAAS-3, 2185 Avionics Circle, Wright-Patterson AFB OH 45433-7301. Tele # 513-255-2191.

AF95-135 TITLE: Solid-State Electronics Applied Research

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Explore innovative semiconductor, electro-optic, and electromagnetic materials and device technologies, and demonstrate concept feasibility.

DESCRIPTION: The following subtopics describe areas of the Directorate mission responsibility in electronics.

a. RESEARCH: Explore revolutionary new device concepts and conduct feasibility demonstration efforts on devices with potential for high frequency microwave/millimeter wave, high-speed electronics, and electro-optical applications.

b. MICROELECTRONICS: Examine new device approaches to logic and electronic processing, ultrahigh speed digital switching devices, advanced semiconductor fabrication technology, high-speed/density integrated circuit packaging, power/thermal management techniques, computer based tools for electronic equipment design, and on-chip sensor/functional testability.

c. MICROWAVES: Investigate promising microwave and millimeter wave solid state and vacuum electronic devices, monolithic integrated circuits, power and low noise amplifiers, signal control components, mixed mode ICs, high density packaging and interconnects, multichip assemblies, computer-aided design/fabrication, subsystem power and thermal distribution technology, and advanced sensor concepts.

d. ELECTRO-OPTICS: Develop new and/or improved lasers and incoherent light sources ranging from deep ultraviolet through infrared (IR) with near IR sources emphasizing 2- to 5- micron tunability; nonlinear devices, materials, and interactions; optical processing (including displays); beam scanners and pointers; modulation and control devices and techniques, including microwave frequencies; detectors and focal plane arrays ranging from 0.15 to 30 microns; micromechanical devices operating in the optical domain; fiber sensors and 2- to 12- micron fiber-optics.

PHASE I: Determine the initial feasibility of the concept through design, physical analysis, mathematical modeling, and measurements.

PHASE II: Develop key processes, validate the model experimentally, explore critical parameters, and optimize the design.

COMMERCIAL POTENTIAL: Commercial applications that will benefit from innovative electron device technological advancements include high temperature electronics for automotive and jet aircraft engines, optical sensors for environmental assessment, high speed digital electronics for computers and communication systems, automotive collision avoidance/warning sensors, and miniaturized diagnostics for the medical industry.

REFERENCES:
R. Anholt, R. Worley, and R. Neidhard, "Statistical Analysis of GaAs MESFET S-Parameter Equivalent-Circuit Models," International Journal of Microwave and Millimeter Wave Computer-Aided Engineering, Vol. 1, No. 3, 263-270, 1991.

AF95-136 TITLE: Safe-Solvent Alternatives to Hazardous Electron-Beam Resists and Developers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Develop safe-solvent electron-beam resists and developers to replace the hazardous standard resists and developers.

DESCRIPTION: Currently, sub-half-micron geometry features in semiconductor electronics are fabricated by E-beam lithography. An E-beam lithography machine writes a pattern onto a semiconductor wafer which is coated with a resist material that is sensitive to the electron beam. The exposed resist material can then be stripped away by an e-beam developer. The remaining resist material provides a mask for a metal deposition or an etch. The fabrication of microelectronic chips is completed by following a process containing a number of similar lithographic steps. The current standard e-beam resist is poly(methylmethacrylate) (PMMA) diluted in approximately 96% chlorobenzene. The current standard e-beam developer is methyl isobutyl ketone (MIBK). An alternative developer is 100% chlorobenzene. These chemicals are considered extremely hazardous and are on the EPA 17 hazardous chemicals list. Sub-half-micron microelectronics are extremely difficult to fabricate without e-beam lithography, which means that these electronics are currently extremely difficult to fabricate without using hazardous chemicals. This program's purpose is to develop safe-solvent resists and developers that perform comparably to the current industry standard resists and developers.

PHASE I: Potential safe-solvent electron-beam resist and developer materials are to be identified and characterized.

PHASE II: The chosen safe-solvent resists and developers are to be optimized for best exposure/develop times, resolution, and process compatibility.

COMMERCIAL POTENTIAL: Electron-beam lithography is used by virtually every microelectronics manufacturer in the world. The standard resist, Poly(methylmethacrylate) (PMMA) diluted in chlorobenzene, is very hazardous. All of the known developers are hazardous as well. Every manufacturer would prefer to use safe-solvent chemicals if they are available and reasonably priced.

REFERENCES:
M. Angelopoulos, N. Patel, J. Shaw, N. Labianca, S. Rishton, "Water Soluble Conducting Polyanilines: Applications in Lithography," J. Vac. Sci. Technol. B, Vol. 11, No. 6, Nov/Dec 1993.

AF95-137 TITLE: Electronic Design Automation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop electronic design automation tools and methods which support complex digital electronic systems design.

DESCRIPTION: The Air Force continuously develops complex electronic components and systems for its weapons. Significant cost savings can be achieved if design times and design errors are reduced and the appropriate factors are considered during the initial design of this equipment. Electronic Design Automation (EDA) or Computer Aided Design (CAD) technologies play a key role in achieving a successful weapon system design while reducing its cost. The AF's primary interest is Electronic System Design Automation (ESDA) tools and design techniques such as VHDL-based performance modeling, abstract capturing of system behavioral requirements, simulatable specifications, VHDL-based virtual prototyping, hardware/software partitioning, synthesis from behavioral descriptions, and parallel processor partitioning. Inputs to the tool should be either an industry standard format such as VHDL, libraries of design choices, or some other natural format that is intuitive to the design team member that is targeted to use this tool. Outputs should be compatible with other tools that are used in follow-on stages of the design process. The tool must have interfaces to the CAD or enterprise framework and data bases on which it is intended to operate. Duplication of capabilities that are already commercially available is strongly discouraged.

PHASE I: The preliminary design of the tool will be performed. The functionality, user interface, and design environment interface will be completely specified.

PHASE II: The tool will be constructed, evaluated, and demonstrated. Reference manuals and user guides will be developed and the tool will be readied for market and tested by potential customers. Production, marketing, and support plans will be developed.

COMMERCIAL POTENTIAL: All tools developed under this topic will be inherently dual-use. This is because the same methods used to design military electronic systems are applicable to commercial systems.

REFERENCES:
ANSI/IEEE 1076 VHSIC Hardware Description Language (VHDL) Reference Manual.

AF95-138 TITLE: Innovative Microelectronics Device Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and demonstrate new device concepts for ultra-high speed, low power, and high density applications.

DESCRIPTION: As we move into the twenty first century, new demands for high speed, low power, high density circuits are rapidly emerging for commercial and military signal, data, and image processing. To date, Metal Oxide Semiconductor Field Effect Transistor (MOSFET) technology dominates the world of high performance silicon circuits, with Complementary Metal Oxide Semiconductor (CMOS) technology playing an important role in low power, high density applications. To meet the ultra-high speed requirements, many integrated circuits (ICs) require the implementation of heterostructure device technologies such as Si-Ge Heterojunction Bipolar Transistors (HBTs), III-V Complementary Heterostructure Field Effect Transistors (C-HFETs), Heterojunction Bipolar Transistors (HBTs), Metal Semiconductor Field Effect Transistors (MESFETs), and others very high performance devices (HEMTs, RTDs, etc.). The intention of this program is to examine new device approaches, rather than the ones listed above, to allow the realization of ultra-high speed, low power, and high density digital switching applications. Emphasis will be given to those technologies that will yield reproducible high density circuits. Selection of the demonstration vehicles shall be based on customers future needs and the availability of suppliers transferring these technologies from a research to a production environment. This program shall be divided into two phases. Device concepts, including material development and fabrication feasibility shall be demonstrated during Phase I. Functional demonstration vehicles and design of potential products shall be completed at the end of Phase II. It is expected that after Phase II, fabrication capability of commercial and military products will be established.

PHASE I: Material growth, characterization, and device feasibility shall be completed.

PHASE II: Functional demonstration vehicles and design of potential products shall be completed.

COMMERCIAL POTENTIAL: Commercial applications for low power, high density, high frequency IC technology include mobile communication equipment and networks, high density logic/memory components, and consumer electronics.

REFERENCES:
A. Cho, "Advances in Material Processing and Device Fabrication," presented at the 2nd International Semiconductor Device Research Symposium (ISDRS '93), pp 7-8 (1993).

R. Dutton, and Z. Yu, "New Challenges in Device Design for Integrated Electronic Systems," presented at the 2nd International Semiconductor Device Research Symposium (ISDRS '93), pp 9-14 (1993).

AF95-139 TITLE: Modeling and Simulation of MMICs and Interconnects in Microwave Packages

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop modeling and simulation capability for active MMICs and interconnects in high density microwave packages.

DESCRIPTION: As microwave packaging becomes more dense and three dimensional, it becomes more challenging to handle interconnects between devices and other MMIC chips. There is a need to be able to accurately model and simulate the electromagnetic and thermal effects of the different vertical interconnects that may be used, such as coaxial interconnects, elastomerics, button boards, etc., between substrates to connect MMICs with other MMICs and digital circuits. The simulation must take into account the different substrate that the interconnect will be passing through (i.e. AlN, LTCC, HT., alumina, AlSiC, etc.) as well as if the chip is flipped or right side up. Another problem that the MCM (Multiple Chip Module) designer faces is the ability to simulate an entire active circuit and obtain the S- parameters needed. The electromagnetic simulator program must be able to include zero-dimensional (mathematical, elements without specific geometry) circuit models of the active devices. These circuit models of the active devices would provide a connection between the input and output micro strip matching networks contained within the package. However, the active device models would not interact electromagnetically with the model. The circuit models of the active devices must include dependent sources (i.e. current-controlled current sources, current-controlled voltage sources, voltage- controlled current sources, and voltage-controlled voltage sources). There are two main tasks of this program, interconnects and active MMICs. The offeror is asked to respond to one or both tasks. The offeror shall report the findings and results to the commercial developers of MCM (Multiple Chip Module) assemblies, high density microwave packages, and Federal agencies involved in developing MCM assemblies.

PHASE I: Research and evaluate 3D EM simulators to assess software packages for the task effort.

PHASE II: Task 1 - Model and simulate a few different types of interconnects. Perform an evaluation between the different interconnects to determine the most reliable approach (lowest loss, most rugged, etc.). Task 2 - Demonstrate the capability to model and obtain S-parameters of an active circuit in a microwave package and compare the results against measured results.

COMMERCIAL POTENTIAL: Commercial applications for accurate modeling and simulation of thermal and electromagnetic packaging effects are needed for any application requiring MCMs. The automotive industry could use this for collision avoidance systems and the Smart Highway System.

REFERENCES:
"Microelectronics Packaging Handbook," Ra R Tamale, 1989, Van Nostrand Reinhold.

"Microcircuit Package Stress Analysis," C. Libore, Syracuse University, RADC-TR-81-382 Technical Report, January 1982, DTIC #820419003.

AF95-140 TITLE: Power Degradation Under RF Overdrive

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Development of reliable screening procedures through determination of electrical/mechanical stress effect on power degradation.

DESCRIPTION: Innovative approaches are required to determine the causes of and solutions to device power degradation and failure under RF overdrive. Reliability screening procedures, which address power slump under RF operation, must also be developed to ensure that solid- state power amplifier manufacturers supply devices that do not exhibit reduced electrical performance over time. Although dc reliability testing of power devices is commonly used, unique device failure under RF drive

has not been effectively investigated and RF reliability screening remains minimal. Reliability screening procedures and the determination of safe RF operating limits for solid-state power transistors (MESFETs, PHEMTs, HBTs) and amplifiers are needed for military and commercial applications, especially satellite communication applications where lifetime requirements are very stringent. The developed electrical and/or visual screening technique should be universally applicable to process-specific devices and be conducive to efficient implementation in a manufacturing environment. This research effort should include the investigation of power slump and the development of a device process less susceptible to power degradation. Novel measurement techniques may be required to RF stress devices and quantify the mechanical or electrical stresses related to power slump, such as increased reverse gate leakage current, decreased open-channel current and increased knee voltage. Device process enhancements for reduced power degradation may include novel transistor passivation schemes to reduce hot-electron trapping. Further, the techniques and processing/fabrication methods proposed for the effort should be environmentally safe.

PHASE I: Determination of the cause and effect relationship between power device electrical and mechanical stresses and output power degradation, with physical and electrical analysis of the devices performed before and after power slump.

PHASE II: The development of a device process less susceptible to power degradation. In addition, the development of reliability screening procedures for power MESFETs, PHEMTs, and HBTs that can be universally applied to process-specific devices to determine safe RF operating limits.

COMMERCIAL POTENTIAL: The transfer and application of the device processing enhancements and the reliability screening procedures to commercial suppliers of power transistors and amplifiers, as well as other federal agencies having similar reliability requirements for solid-state devices used in their missions.

REFERENCES:

H. Hasegawa et al., "High Reliability Power GaAs MESFET under RF Overdrive Condition," IEEE MTT-S Digest, 1993, pp 289-292.

Y.A. Tkachenko et al., "Gradual Degradation under RF Overdrive of Power GaAS Field-Effect Transistors," GaAs Reliability Workshop Digest, 1993.

J.M. Dumas et al., "Long Term Degradation of GaAs Power MESFETs Induced by Surface Effects," Proc. 1983 Int'l Reliability Physics Symposium, pp 226-227.

S. Igi et al., "The Effects of the Passivation Film on the Reliability of High Power GaAs MESFETs," Proc. ISTFA, 1983, pp 302-310.

AF95-141 TITLE: Ultraviolet Detection and Device Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop and demonstrate the optical properties and performance of ultraviolet detection mechanisms for solid-state devices.

DESCRIPTION: Succeeding development of intrinsic/extrinsic photovoltaic or photoluminescent based solid state ultraviolet (UV) detection schemes and fabricated detectors is needed for the 2000 to 3000 Angstrom wavelength region, i.e. solar blind, for both point source and imaging applications. Program consideration may address one or more of the areas of emphasis accented below. Emphasis should be placed on the physical processes limiting material properties which impact detector equivalent circuit performance. Emphasis should be placed on device fabrication development to include crystal growth and detector fabrication including contacts. Emphasis should be placed on development of the optical properties of coupling UV radiation into the detector structure by antireflection, interference, and diffraction. Emphasis should be placed on the equivalent circuit of the detector and detector ideal and comparative actual signal-to-noise performance and frequency response. Emphasis should be placed on detector signal preamplification and amplification with corresponding test and evaluation at a number of UV emission lines in the 2000 to 3000 Angstrom region and 3100 to 3900 Angstrom region comparing an ideal UV detector noise equivalent power (NEP) and D*lambda. Performance to the measured detector Performance- Emphasis should be placed on physical processes limiting measured detector performance. Complete detector and preamp technology samples will be used for laboratory and field tests. Applications could include missile threat warning, theater ballistic missile launch, UV search and track, UV laser recording, cockpit display, heads-up display, jet engine monitoring and combustion control, and optical circuit signal processing.

PHASE I: Material growth and single detector characterization shall be completed with discussion of the theoretical considerations addressing the other areas of emphasis as listed in the topic description.

PHASE II: Growth of optimized structures (detector and detector arrays), fabrication and characterization along with preamp design and fabrication to allow for detector and preamp technology performance measurements to indicate maturity level achieved.

COMMERCIAL POTENTIAL: Commercial applications for low cost ultraviolet sensor technology include flame sensors, automobile engine combustion sensor; medical/astronomy applications, and environmental monitoring.

REFERENCES:

M. Asif Klan, A.R. Bhattarai, J.N. Kuznia and D.T. Olson, Appl. Phys. Lett. 63, 1214 (1993).

I. Akaski, H. Amano, Optoelectron. Devices Technol. 7, 49 (1992).

M.A. Khan, R.A. Skogman, J.M. Van Hove, S. Krishnankutty and R.M. Kolbas, Appl. Phys. Lett. 56, 1257 (1993).

J.D. Zook, B.L. Goldenberg, L.R. Reitz and J.A. Van Vechten, Bulletin of the American Physical Society, Vol 38, 675 (1993).

AF95-142 TITLE: Variable Flux Group III Source for III-V Solid Source MBE

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a source that provides rapid, controllable incident flux variation during solid source MBE growth.

DESCRIPTION: Solid source molecular beam epitaxy (MBE) utilizes group III cells containing In, Ga, and Al melts from which atomic vapors emanate towards the substrate. Relatively constant group III fluxes are obtained by controlling the cell temperatures, and thus the vapor pressures, of the group III elements. Many advanced electronic and photonic device structures possess compositionally graded regions which are difficult to produce with present group III source technology. The approach often taken to produce compositionally graded structures has been to vary the source temperature in time, a method which suffers greatly from reproducibility and thermal lag issues. The controlled growth of such compositionally graded regions would be enabled by the development of a variable flux group III source. Such a source should provide for controllable, continuous changes in incident flux as would be useful, for example, in the growth of a graded emitter layer in a heterojunction bipolar transistor structure. The source should also provide for large and controllable flux variations to be effected on a time-scale of one second or less, thereby providing the potential for monolayer-abrupt composition transitions when desired, as would be useful, for example, at an Al(sub x)Ga(sub 1-x)As/Al(sub y)Ga(sub 1-y)As junction in a laser diode. The magnitude of flux variation available from the source determines the magnitudes of composition variation available and thus should be made as large as is feasible. The operating characteristics of the source should not be deleterious to the MBE growth process, and the source configuration should provide for ease of its implementation on most commercial MBE machines.

PHASE I: Emphasis will be placed on developing a prototype source and demonstrating its ability to provide controllable flux variations of large magnitude on a rapid time-scale.

PHASE II: Focus will be placed on further developing the prototype source with emphasis on ease of use, longevity, repeatability and optimizing its ability to provide controllable flux variations of large magnitude on a rapid time-scale. The source will be demonstrated in a commercial solid source MBE by growth and characterization of a complex III-V heterostructure structure.

COMMERCIAL POTENTIAL: Development of a variable flux group III source would significantly improve III-V electronic and photonic device production technology with many commercial applications, including automotive, aircraft, satellite communications, and high speed computing.

REFERENCES:

M.A. Herman and H. Sitter, "Molecular Beam Epitaxy," Springer Series in Materials Science Vol. 7, Springer-Verlag, Berlin 1989.

AF95-143 TITLE: Magneto Hall Effect System to Characterize High-Speed Device Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Design apparatus to determine carrier concentration and mobility in semiconductor materials with two conductive layers.

DESCRIPTION: Materials for present-day high speed devices, such as the high electron mobility transistor (HEMT) and pseudomorphic HEMT (pHEMT), often have two conductive layers; thus, the common Hall- effect technique cannot be used to analyze such materials. The problem is that the standard Hall-effect method measures only two parameters, the conductivity s, and Hall coefficient R, and thus is able to determine only two unknowns, the carrier concentration n and mobility mu in a single layer. However, extra information can be obtained by measuring the magnetic field dependencies of s and R, and algorithms have been devised to determine n and mu in two layers. What is needed is a convenient automated apparatus, including both hardware and software, to carry out these "magneto-Hall" or M-Hall measurements. Features of the apparatus should include a current source capable of supplying 1 nA-100 mA and a voltmeter capable of measuring 1 muV to 100 V. Neither instrument should load appreciably for sample resistances below 100 megaOhms. Magnetic field strengths up to 15 kG (1.5T) should be attainable. Low temperature operation, at least down to 80 K should be an option. If commercial instruments are used for some or all of the functions, they should be well integrated and automated through the use of MSDOS compatible software.

PHASE I: Detailed design plans, including all major components.

PHASE II: Construction of apparatus and demonstration on typical pHEMT material.

COMMERCIAL POTENTIAL: The Hall effect technique is one of the most common characterization methods used in the semiconductor field. The two-layer capability will allow it to be used for digital and microwave devices found in diverse systems such as radar amplifiers and global positioning systems.

REFERENCES:
D.C. Look, C.E. Stutz, and C.A. Bozada, Journal of Applied Physics, Vol 74 (1), 1 July (1993) pp 311.

AF95-144 TITLE: Aircraft Drag Reduction Using Active Techniques

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Extend the range of military aircraft through the practical application of Active Drag Reduction Systems

DESCRIPTION: Aerodynamics drag is the major factor limiting aircraft range. Modern aircraft design practices tend to minimize the profile, induced and compressibility drag components by sizing the aircraft for specific mission needs. The friction and interference drag components are not as easily controlled in the design process; however, these drag components can be markedly reduced by the practical application of innovative active drag reduction devices. Recent skin friction drag reduction technology, such as the government sponsored laminar flow control flight experiments, have shown that the pneumatic control of aircraft skin friction drag can have a major impact on aircraft range improvement. The next big strides in skin friction and interference drag improvement can be made by linking microprocessors with aerodynamic boundary layer control devices to optimize flow control on or near the aircraft surface. The development and application of properly controlled active boundary layer and/or separated flow control devices offers the potential for dramatically improving the range of military aircraft. Also, the technology developed is directly applicable to commercial aircraft.

PHASE I: Experimental demonstration of an active drag reduction device that will extend the range of military aircraft by controlling the aircraft boundary layer in a practical way.

PHASE II: Active drag reduction device performance validation under simulated flight Conditions.

COMMERCIAL POTENTIAL: Commercial aircraft industry. One of the highest leverage technologies in the competitive commercial aircraft development field is aircraft drag reduction. The US commercial aircraft industry has made great strides in building efficient transport aircraft by applying the latest passive drag reduction technologies to their current production fleet. Application of active drag reduction techniques, such as those to be developed under this program, offer new horizons in commercial aircraft performance that when properly exploited can lengthen the competitive edge our industry holds over commercial aircraft manufacturers throughout the world.

REFERENCES:
Clark, R., C.; Lange, R.H; and Wagner, R.D. "Application of Advanced Technologies to Future Military Transports." AGARD-CP-495, Paper 17, May 1990.

AF95-145 TITLE: Enhanced Algorithms for Cockpit Voice Recognition Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Combine Multiple speech recognition algorithms on one hardware platform to maximize connected speech recognition accuracy.

DESCRIPTION: The Air Force is interested in developing a speaker dependent, multiple algorithm connected-speech recognition system for use in fighter and transport cockpits. Once fully developed, the aircrew will be able to manipulate displays, menus, modes, and communication tasks through voice control. This effort will focus on designing three connected-speech recognition algorithms to be placed on a single hardware board. Each one of these algorithms will take a different approach to the speech recognition problem. The resulting board must be constructed from commercial off-shelf components for which there are Military-Standard equivalents. The board itself must fit into a full-size Disk Operating System (DOS) personal computer (PC) bus slot and be functional with software running on a DOS PC. The three individual algorithms will work in unison to recognize phrases uttered by the aircrew in the cockpit environment with at least 99% word accuracy. This includes recognizing commands during aircraft buffeting and vibration, maneuvering accelerations (g-loading from -3 to +9 in the z-axis), under operational aircraft cockpit noise levels, and during moments of high pilot workload and mental stress.

PHASE I: This phase will define the proposed concept, investigate algorithm alternatives, propose hardware and software designs for the three candidate algorithms to be placed on the hardware platform, and predict the performance of the proposed design.

PHASE II: This phase will require the contractor to build the voice algorithms and incorporate them onto a hardware platform. The combined voice system shall be tested for accuracy using operational aircrew vocabularies under simulated cockpit environments (i.e. vibration, noise, and Acceleration).

COMMERCIAL POTENTIAL: Improvement in connected speech recognition systems can be used for commercial telecommunications, voice security systems, commercial and private aircraft, handicap applications, as well as medical (surgery) aids.

REFERENCES:
Barry, T., Liggett, K.K., Williamson, D.T. and Reising , J.M., "Enhanced Recognition Accuracy with the Simultaneous Use of Three Automated Speech Recognition Systems," In the Proceedings of the Human Factors Society 36th Annual Meeting, Atlanta GA, (pp. 288-292), 1992.

Simpson, C.A., "Evaluation of Speech Recognizers for Use in Advanced Combat Helicopter Crew Station Research and Development," USAAAVSCOM Technical Memorandum 90-A-001, Ames Research Center, Moffett Field CA, 1990.

AF95-146 TITLE: Flight Control Technology and Integration

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Navigation, Guidance & Vehicle Control

OBJECTIVE: Develop flight control and integration technology to support Global Reach, Global Power through affordable aircraft of the 21st Century.

DESCRIPTION: The Air Force is interested in the development of one or more of the following advanced flight control and integration technologies for future aircraft: a)innovative control effectors for military transports, b)flying qualities research, c)software for checking compliance with flying qualities requirements, d)software for predicting stability and control parameters of aircraft/missile configurations as a function of roll rate, e)high-fidelity modeling techniques for simulation/flight control analysis involving nonlinear and time varying aerodynamics, f)self-repairing flight control methods including algorithms and/or criteria to help allocate control authority, g)self-repairing control methods to deal with control saturation that might be exacerbated by sudden failure or damage, h)unique hydraulic, pneumatic, and electric technologies capable of reducing the complexity of the flight control actuation system, i)flight management techniques including trajectory optimization concepts to increase pilot/vehicle/mission effectiveness considering both single and multiple air vehicle operations, j)fuzzy logic based aircraft flight control, k)structural response feedback techniques for flight control, l)on-board system diagnostics concepts for highly integrated vehicle management systems, m)control system configuration for nonlinear and time varying flight conditions, n)real-time, high-fidelity multisensor image fusion software for piloted vehicle control.

PHASE I: Expectations include determining the feasibility, preliminary concept identification and requirements definition. Some specific examples are the identification of promising control effector concepts to move into testing, requirements

generation and development plan for PC based flying qualities compliance software, promising control actuation concepts/designs, and assessment and selection of one or two multisensor fusion techniques to move into testing.

PHASE II: Expectations include hardware fabrication, ground testing, simulation or flight testing, and validated, executable software code. Some specific examples include validated design of one or two high efficiency control effectors, validated flying qualities compliance executable software code, software development, and demonstration of image fusion Technique.

COMMERCIAL POTENTIAL: The technology developed will provide for reduced fuel consumption for transport aircraft, reduced design and development costs for flight control systems, more efficient and supportable flight control system architectures, and ability to operate aircraft safely and effectively in low visible conditions. All of the items in this SBIR topic are equally applicable to the civilian and military aircraft sectors.

REFERENCES:

P.R. Chandler, M. Pachter, M. Mears, "Constrained Linear Regression for Flight Control Failure Identification," American Control Conference, San Francisco CA, June 1993.

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D. Murri, G. Shah, D. Di Carlo, T. Trilling, "Actuated Forebody Strake Controls for the F-18 Hight-Alpha Research Vehicle," AIAA Atmospheric Flight Mechanics Conference, Monterey CA, August 1993.

J.E. Jenkins, "Simplification of Nonlinear Indicial Response Models: Assessment for the Two-Dimensional Airfoil Case," Journal of Aircraft, Volume 28, Number 2, February 1991.

S. Chetty and P. Lakshmi, "Computer Aided Evaluation of Aircraft Handling Qualities," 5th IFAC/IMACS Symposium on Computer Aided Design in Control Systems, Swansea, U.K., July 1991.

AF95-147 TITLE: Aging Aircraft

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop methodologies for determining, assessing, and predicting the effects of various forms of aircraft service damage.

DESCRIPTION: One or more of the emphasis areas identified below under a)Damage/Life/Risk Assessment of Aircraft Structures and/or b)Dynamic Effects on Aircraft Structural Integrity must be addressed.

a. Damage/Life/Risk Assessment of Aircraft Structures: A variety of critical service problems are currently plaguing our aging aircraft fleets and threatening them with grounding or shortened service lives because accurate methodologies for prediction and assessment do not exist today. These problems include but are not limited to corrosion fatigue, multiple-site damage (MSD), fretting fatigue, fretting corrosion, joint debonding, composite delamination, and composite impact damage. Research efforts should involve enhancing damage detection methods, generating analytical methodologies for predicting the effects of various forms of aircraft structural damage, validating these methodologies through experimental testing, and turning these methodologies into accurate predictive computer models. These models shall be suitable for integration into PC based, deterministic fatigue crack growth and probabilistic risk assessment computer programs. Emphasis areas are as follows: 1)Corrosion detection sensor in inaccessible/hidden areas. 2)Corrosion testing techniques (e.g. correlation of corrosion data produced in a laboratory environment with corrosion data from aging aircraft by developing the appropriate transformation functions). 3)Methodology to predict fatigue and corrosion effects (e.g. due to fretting) on aging aircraft structures. 4)Fatigue crack growth analysis model (e.g. in the plastic zone). 5)Advanced life extension techniques (e.g. laser shock processing).

b. Dynamic Effects on Aircraft Structural Integrity: Unsteady/separated flows are producing excessive dynamics loads in the form of acoustics, buffet, flutter, and vibration which result in premature structural failures and exorbitant repair time and costs. For example, aeroacoustic loads generated by turbulent boundary layers in attached and separated flows have a significant impact on the vibration response of aircraft structures and externally carried stores. Moreover, the transonic flow regime can produce rms pressure loads an order of magnitude over attached flow levels commensurate with that encountered with separated flow regimes. Emphasis areas are as follows: 1)Methods for predicting and techniques for alleviating buffet. 2)Techniques for actively suppressing flow induced weapons bay acoustics. 3)Methodology for predicting aeroacoustic loads

associated with attached and separated subsonic, transonic, and supersonic flows. 4)Methodology for analyzing high angles of attack in fighter aircraft.

PHASE I: The desired end products are: a) computer code modules suitable for integration with existing deterministic fatigue crack growth and probabilistic risk assessment computer programs, b)established techniques, and/or c)sensor design.

PHASE II: Expected work to be accomplished is through experimental validation of the methodologies, techniques, and/or sensors designed as a result of Phase I efforts.

COMMERCIAL POTENTIAL: The Methodologies, techniques, and/or sensors would be directly applicable and transportable to other industries (e.g. automotive, shipping, railroad, and nuclear). The commercialization potential is extremely high.

REFERENCES:
Waterhouse, R. B. "Environmental Effects in Fretting, Fatigue, and Fretting Fatigue," 10th International Congress on Metallic Corrosion., undated.

Muck, K.C., Dussauge, J.P., and Bogdonoff, S.M., "Structures of the Wall Pressure Fluctuations in a Shock-Induced Separated Turbulent Flow," AIAA Paper 85-1079, Jan 1985.

Hirsch, Charles, "Numerical Computation of Internal and External Flows," Vol. I, "Fundamentals of Numerical Discretization," 1988, Vol. II, "Computational Methods for Inviscid and Viscous Flows," 1990, John Wiley and Sons, Inc., New York.

AF95-148 TITLE: Advanced Design Methods for Aircraft Structural Technology Integration

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Design Automation

OBJECTIVE: Develop advanced design and analysis methods and supporting test instrumentation for aircraft structures.

DESCRIPTION: The Air Force is seeking new and innovative design and analysis methods to enable the integration of new and highly innovative technologies into aircraft structures. Design and analysis methods significantly influence aircraft structure performance parameters such as weight, cost, signature, service life, producibility, and supportability. New structural design and analysis methods are needed to support the development of multidisciplinary design optimization (MDO). The objective is to reduce the design cycle time and to simultaneously optimize performance parameters to meet increasingly stringent design and affordability requirements. Design methods are needed to address the integration of aerodynamics (including recent development in computational fluid dynamics) and flight controls in the context of aircraft structural design optimization. New instrumentation technology is also sought to benchmark design and analysis methods. Design and analysis methods are sought for three emerging classes of structural concepts: lightweight, low-cost, low signature structures, smart structures, and thermal structures. The impact of conceptual design and preliminary design on the weight, cost, and signature of structures is significant. Low cost concurrent engineering optimization methods are needed to fuse performance requirements with producibility and supportability requirements. New design and analysis methods are needed for smart structures with embedded sensors, actuators, and processors for structural health monitoring and damage detection, radio frequency antenna performance, and active vibration and structural shape control. Methods are required to analyze and predict embedded sensor performance, process and interpret sensor data, and predict the effects of embedded sensors on the strength, durability, and damage tolerance of structure. Methods are required to analyze and predict embedded actuator performance and global structural response to embedded actuators. Smart material sensor arrays are required for measuring real-time, steady-state, dynamic strain. Finally, new design and analysis methods are required for extreme environment structures of high mach (> Mach 3) vehicles and engine exhaust impinged structures subjected to combined high temperature and acoustic environments. Methods for structural life prediction in these environments are required. A high temperature microphone for sound measurements of up to 20,000 - 50,000 Hz and 180 dB at temperatures up to 3000■F is required to verify thermostructural analysis.

PHASE I: The Phase I program must demonstrate the feasibility of the proposed design and analysis method or instrumentation technology sufficient to justify further development and/or scale-up in a Phase II effort. The Phase I effort should focus on one of the design and analysis methods or instrumentation requirements described above.

PHASE II: The technology demonstrated in Phase I will be developed in detail. The payoffs and benefits of the technology will be demonstrated by application or testing to meet Air Force Objectives.

COMMERCIAL POTENTIAL: The advanced design and analysis methods being sought have great potential for commercial market use in the civil transportation industry for design of aircraft, automobiles, trucks, buses, and rail cars, and in civil engineering for design of buildings, bridges, and industrial structures.

REFERENCES:
Niu, Michael C. Y., "Airframe Structural Design," Conmilit Press, Ltd., 1988.

Clevenson, S. A., Daniels, E. F., "Capabilities of the Thermal Acoustic Fatigue Apparatus," NASA-TM-104106, Feb. 92 (NTIS N92-22212/4/XAB).

Seebass, A. R., Editor in Chief, "Thermal Structures Materials for High Speed Flight," AIAA Technical Journal, Volume 140, AIAA Publications, 1992.

AF95-149 TITLE: Products To Reduce Aircraft Transparency System Cost Of Ownership

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: To develop materials, products, and processes that will reduce the cost of ownership for aircraft transparency systems.

DESCRIPTION: Innovative and cost effective concepts are being sought which will reduce the cost of ownership of aircraft transparency systems. Potential areas for investment include nondestructive assessment of in-service transparencies for residual structural toughness; material durability against chemical agents; restoration of optical quality, inflight or on the ground; new manufacturing processes such as casting transparency systems with integral frames; and recycling of transparent materials.

PHASE I: Evaluate methods for cost savings to the Air Force and commercial benefit to industry. Demonstrate feasibility and approach of selected methods.

PHASE II: Develop and test prototype System.

COMMERCIAL POTENTIAL: Products will be a process which will reduce the cost of transparency ownership and yield a higher quality product for commercial products.

REFERENCES:
Chemical and Bio Warfare: Protection, Decom, & Disposal (250 citations), NTIS # PB93-864270, Apr 93.

Marolo, S.A., Conference on Aerospace Transparent Materials and Enclosures, Volumes I & II, Wright Research and Development Center, WRDC-TR-89-4044, April 1989.

"System for Separation and Granulation of Plastics," REV.PLAST.MOD.: 38, No. 280, Oct 79, p 535-7.

AF95-150 TITLE: Training Fire Fighters Through Virtual Reality Applications

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Computers

OBJECTIVE: Develop a fire fighter oriented virtual reality training system to improve skills in aircraft rescue, structural fire fighting and hazardous material mitigation.

DESCRIPTION: Development of a virtual reality fire fighter training system will facilitate significant improvements in fire suppression, aircraft rescue and hazardous material mitigation operations and result in improved human behavioral responses. The system will employ a complete fire fighter ensemble, integrated breathing air system and three-dimensional facepiece that provides projection of advanced computer generated fire scenarios to the wearers field of view, coupled with intensification of fire spread, structural collapse, backdraft indicators, actual heat development, and smoke odors. The system will induce stress levels in the training environment through the use of sound effects. Likewise, the training system will employ distinct hardware technologies such as head mounted displays, position/orientation sensors and high speed graphics. The potential for use of this system is multifaceted. Benefits to fire fighter performance are expected. Other direct benefits include an environmentally friendly system without the actual burning of hydrocarbon fuels thus eliminating potential air pollution, reduction in training manhour expenditures, measurable performance standards, instant feedback concerning performance and state-of-the-art training mediums.

PHASE I: This work effort will include a preliminary analysis of the application of virtual reality to the training of fire fighters. Particular emphasis will be the development of user friendly, instructor programmed interactive fire scenarios.

Proof of technical feasibility, preliminary design, assessment of operational requirements and selection of hardware and software concepts will be included in Phase I development.

PHASE II: This work effort will be the integration of system components (hardware/software, SCBA, vision system, sound effects and position orientation) into a working model/system. A demonstrated performance through a single integrated system will be conducted and Validated.

COMMERCIAL POTENTIAL: Potential customers include all DoD fire service organizations, state and local fire departments and fire academies. Likewise, the use of an environmentally friendly and cost effective training system has unlimited potential in the area of hazardous material mitigation.

REFERENCES:

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AF95-151 TITLE: Diagnostic System for Unsteady Flow Fields

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: To collect quantitative data from wind tunnels using a nonintrusive method which is capable of making on- or off-body, global measurements of unsteady flow fields.

DESCRIPTION: Substantive advancements in both military and commercial flight vehicles hinge on understanding and exploiting unsteady flow phenomena. Wind tunnel tests require quantitative measurements of velocity and pressure throughout the flow field and detailed pressure measurements on the model for purposes of computational fluid dynamics code validation. Since probes inserted into the flow field may disturb the flow, these data must be taken by nonintrusive means. Furthermore, to allow detailed investigation of unsteady flow fields, these methods must allow simultaneous measurements on entire planes in the flow field or entire surfaces on the model. Some planar methods, such as Doppler Global Velocimetry (DGV) are capable of making global velocity measurements in the flow field. Others, such as Planar Laser Induced Fluorescence (PLIF) are capable of making density measurements. In addition, photoluminescent coatings on models have been used to make steady pressure measurements, but are not currently capable of making transient or unsteady measurements. All these methods face limitations in unsteady flow fields because of the amount of data which must be acquired at high speeds. A new method to augment these techniques or substantial extensions of existing methods is desired. Ideally, this method would simultaneously provide both velocity and pressure information throughout the flow field and pressure information on the model surface. This method must provide nonintrusive measurements and would most likely be optically based. Any seeding material used must be environmentally nonhazardous. In addition, the data acquisition hardware required to provide temporal resolution of unsteady flow fields for such a method may also need to be developed. This would require shutter speeds of less than 1 millisecond and frame rates of approximately 100 Hz.

PHASE I: Activity would identify a new diagnostic system or substantial advancements to existing techniques and the optical requirements, tunnel modifications, computer requirements and data reduction techniques applicable to this task.

PHASE II: Phase II would design and build the diagnostic system, including any specialized data acquisition hardware and data reduction software and install the system in the Subsonic Aerodynamics Research Laboratory (SARL) wind tunnel in Wright Laboratory, or other facility, as Suitable.

COMMERCIAL POTENTIAL: Significant advances in the use of photoluminescent coatings or flow-field diagnostics have the potential of making a tremendous impact in the commercial aircraft, automotive and trucking industries. Improved fuel economy due to decreased vehicle drag might be achieved cost effectively by utilizing enhanced diagnostic systems. Commercial wind tunnel tests and wind tunnel models may become simpler and less expensive while yielding orders of magnitude more data than is possible using existing testing techniques.

REFERENCES:

Seibert, G.L., "Nonintrusive Measurements in Fluid Dynamic Flows from Mach .005 to 14," ICIASF '91-14th International Congress on Instrumentation in Aerospace Simulation Facilities, Rockville, MD, IEEE 1991, pp 74-81, October 1991.

Lee, M.P., Paul, P.H., and Hanson, R.K., "Quantitative Imaging of Temperature Fields in Air Using Planar Laser-Induced Fluorescence of O2," Optics Letters, Vol. 12, No. 2, February 1987.

Lee, J.W., Meyers, J.F., Cavone, A.A., and Suzuki, K.E., "Doppler Global Velocimetry Measurements of the Vortical Flow Above an F/A-18," AIAA 93-0414, January 1993.

Hammer, M., Campbell, B., Liu, T., Sullivan, J., "A Scanning Laser System for Temperature and Pressure Sensitive Paint", AIAA 94-0728, January 1994.

Donovan, J.F., Morris, M.J., Pal, A., Benne, M.E., Crites, R.C., "Data Analysis Techniques for Pressure- and Temperature-Sensitive Paint", AIAA 93-0176, 1993.

McLachlan, B.G., Kavandi, J.L., Callis, J.B., Gouterman, M., Green, E., Khalil, G., Burns, D., "Surface Pressure Mapping Using Luminescent Coatings", Experiments in Fluids, 1993.

Morris, M.J., Benne, M.E., Crites, R.C., Donovan, J.F., "Aerodynamic Measurements Based on Photolumenescence", AIAA 93-0175, 1993.

AF95-152 TITLE: Nonintrusive Internal Stress/Strain Sensor

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop a nonintrusive sensor for measuring transverse stress/strain with composite materials.

DESCRIPTION: Current research requires measurement of stress/strain within composite laminate targets during ballistic impact. Conventional stress and strain gauges have been embedded within laminates to measure transverse stress waves. These sensors proved intrusive due to sensors size and temperature limitations. Fiber-optic sensors have been successfully embedded into laminates but are configured to measure solely the in-plane response. New sensors must be nonintrusive to the composite laminate and capable of measuring transverse tension and compression. Sensors developed for this effort must survive common temperatures and pressures associated with the fabrication of thermoset and thermoplastic composite structures. The operating temperature range of these sensors will be -40 through 1200 F.

PHASE I: A conceptual design supported by theory and proven methods will be provided at the conclusion of the program.

PHASE II: Proof of concept will be demonstrated during the Phase II effort. A fully operational prototype, meeting the established requirements, will be delivered at the end of this Phase.

COMMERCIAL POTENTIAL: A sensor meeting the requirements of this research effort will allow nondestructive structural analysis and failure prediction for composite components within the automotive and recreational industries.

REFERENCES:
G.J. Czarnecki, "A Preliminary Investigation of Dual Mode Fracture Sustained by Graphite/Epoxy Laminates Impacted by High-Velocity Spherical Metallic Projectiles," MS Thesis, University of Dayton OH (1992)

AF95-153 TITLE: Lightweight Longspan Roof Framing System

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop a lightweight, air transportable, longspan roof framing system that can be field assembled.

DESCRIPTION: The spanning of long distances in roof systems for earth covered structures is a major design problem using standard concrete beam designs. Lightweight modular construction systems have been developed for rapid construction of floors and walls, but existing design methods have not produced a long span system light enough for practical use. Innovative geometries coupled with lightweight materials need to be integrated into new roof framing systems to span distances of 70' to 80' or greater. Service loads of up to 500 lb/ft^2 are goals to achieve.

PHASE I: Proposed innovative systems that meet the requirements, which can include innovative and original geometric configurations, materials or a combination of both. A detailed numerical analysis of the proposed system will demonstrate the capability of the system to meet the requirements.

PHASE II: Perform scaled testing of selected systems to verify numerical analyses. One tested system will be 1/4 scale or larger. Complete instrumentation data of system tests will be required. Innovative connection methods and assembly techniques will be proposed in this phase.

COMMERCIAL POTENTIAL: These systems would have dual use as low cost, rapidly erectable construction systems to meet recovery needs following natural disasters such as earthquakes, hurricanes, tornado and fire. Once installed the system could become a permanent structure or disassembled and the area returned to its natural state with minimal effort.

REFERENCES:
Brilhante, R.P., and Saab, E. E., Highly Erectable Dome Shelter, Final Report to Headquarters Air Force Engineering and Services Center, ESL-TR-89-17, Tyndall AFB FL, March 1989.

AF95-154 TITLE: Engineering Flight Simulator Technologies

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Navigation, Guidance & Vehicle Control

OBJECTIVE: Develop innovative flight simulation technologies to support development of Advanced Aircraft and Strike Tactics.

DESCRIPTION: The Air Force is interested in innovative new flight simulation technologies which will advance the state of the art in support of systems development or aircraft control for Advanced Aircraft. Research in the area of improved network simulation fidelity, latency reduction, or cost reduction for simulator hardware on a network are of particular interest. Emphasis is desired in the area of simulation fidelity between nodes on a long haul network or between subsystems or hardware-in-the-loop for local area simulation networks. Novel display technologies, lower life cycle cost simulation techniques, or improved techniques for conducting research using networked simulation are also sought. Application of commercial virtual reality technologies to simplify or improve research simulation is encouraged. Innovative approaches for the use of large High Definition Television (HDTV) aspect ratio Cathode Ray Tubes (CRTs) in flight simulator instrument panels, or low cost approaches for prototyping simulation instrument panel controls/displays is of interest. Improvements will be considered for any technology, hardware device, or software program which shows potential for flight simulation advancement.

PHASE I: The Phase I effort shall define the proposed concept, investigate alternatives, and predict performance of the proposed design. Demonstrations of high-risk portions of the design are encouraged, but not required.

PHASE II: Phase II shall fully implement, demonstrate, and test the Phase I design. Results of the test and recommendations from improvements and/or alternatives shall be documented.

COMMERCIAL POTENTIAL: Improvements in flight simulation technology typically have application with some modification to flight simulators used by the airline industry to satisfy FAA training requirements.

AF95-155 TITLE: Advanced Structural Concepts

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop and demonstrate advanced structural concepts for aircraft structures.

DESCRIPTION: The Air Force is seeking new and highly innovative concepts for aircraft structures. Concepts exploiting new designs and structural arrangements, embedded sensors and actuators, new materials, and innovative manufacturing approaches are sought. Concurrent engineering approaches will be required to optimize structural performance and simultaneously satisfy producibility and supportability requirements. New concepts are sought for lightweight, low-cost, low signature structures, smart structures, and elevated temperature structures. There is a critical need to simultaneously reduce the weight, cost, and signature of aircraft structures. New design concepts, materials, and manufacturing processes need to be exploited. Concepts reducing part count and fastener count for both composite and metallic structures offer potential. Concepts for smart structures with embedded sensors, actuators, and processors for structural health monitoring and damage detection, radio frequency antenna performance, and active vibration and structural shape control are sought. Concepts demonstrating sensor and actuator integration and performance need development. Concepts are also needed for elevated temperature structures of high mach (> Mach 3)

vehicle and engine exhaust impinged structures subjected to high temperature and acoustic environments. Lightweight organic composite concepts utilizing innovative thermal management concepts and infrared emission attenuation technologies are sought.

PHASE I: The Phase I program must demonstrate the feasibility of the proposed concept sufficient to justify further development and/or scale-up in a Phase II effort. Proof of concept subcomponents should be fabricated and tested.

PHASE II: The concepts demonstrated in Phase I will be scaled-up and developed in detail. The payoffs and benefits of the technology will be demonstrated by fabrication and testing to meet Air Force Requirements.

COMMERCIAL POTENTIAL: The advanced structural concepts being sought have great potential for commercial market use in the civil transportation industry for aircraft, automobiles, trucks, buses, and boats, in the commercial space industry for boosters and satellites, and in the high performance sporting goods industry for golf clubs, tennis rackets, fishing rods, skis, and bicycles.

REFERENCES:

Niu, Michael C. Y., "Airframe Structural Design," Conmilit Press, Ltd., 1988.

Clevenson, S. A., Daniels, E. F., "Capabilities of the Thermal Acoustic Fatigue Apparatus," NASA-TM-104106, Feb. 92 (NTIS N92-22212/4/XAB).

Seebass, A. R., Editor in Chief, "Thermal Structures Materials for High Speed Flight,"AIAA Technical Journal, Volume 140, AIAA Publications, 1992.

AF95-156 TITLE: Multiple Degrees of Freedom Real-Time Flight Rerouting

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Human-System Interfaces

OBJECTIVE: Improve current abilities in aircraft rerouting to avoid sudden threats to flight safety.

DESCRIPTION: Traditional flight plans for commercial and military aircraft do not account for sudden threats to flight safety that are unknown during initial flight planning. When adverse weather, inoperable runways, mid-air collisions, military hazards, or other sudden threats appear unexpectedly, there may be very little time for a pilot to reach decisions about how to reroute the aircraft to ensure flight safety and mission completion. Algorithms are sought that enhance traditional optimization and estimation techniques for the real-time on-board in-flight computation of maneuvers and flight paths that take advantage of such multiple degrees of freedom as altitude, heading, airspeed, terrain, and other countermeasures to avoid sudden threats to flight safety. Threats can be ground-based or airborne, have various spheres of influence, and be mobile. The algorithms must take into account the capability of the host aircraft, its remaining fuel, and Air Traffic Control inputs. The algorithms must be capable of minimizing either the threat to safety or the time to mission completion, as selected by the aircrew. The aircrew also needs the option of selecting required waypoints and modifying waypoints selected by the algorithm. Ideally, these algorithms will use conventional observables and provide real-time recommendations using a continuously updated display. The successful offeror must provide convincing evidence that the proposed approach will not require excessive throughput or specialized resources.

PHASE I: Requirements definition, system concept architecture definition sufficient to generate software code in Ada, and real-time metrics development. Select the optimization and estimation algorithms to be used and demonstrate their speed, performance, and computational feasibility for countering and/or avoiding a threatening situation composed of dual threats to flight safety. Propose a method for applying these algorithms to more complex situations involving multiple mobile threats at multiple altitudes, of various speeds, and having various spheres of influence.

PHASE II: Prototype development, demonstration, and comparison to real-time metrics. All software should be written in Ada to facilitate technology transition. Refine the algorithms to consider mission objectives that may include multiple aircraft, multiple (potentially airborne and/or mobile) threats to flight safety, as well as multiple and irregular terrain Features.

COMMERCIAL POTENTIAL: The real-time embedded intelligent systems capabilities developed in this program would have applications in commercial aircraft. Most obvious would be the critical arena of collision and weather avoidance. It is typically the case that intelligent systems are touted as "near real time." This project encourages a graduation to "true real time" for a difficult application in pilot workload reduction. Commercial application would apply to a large class of optimization, display, and control problems widely encountered in the airline industry, vehicular control, and process control (particularly for chemical, petrochemical, and biochemical industries).

REFERENCES:

NTIS Number: N92-27895/1/XAB; Knowledge-Based Planning for Controlled Airspace Flight Operation as Part of a Cockpit Assistant.

NTIS Number: N91-12677/1/XAB; Diverter Decision Aiding for in-Flight Diversions (Final Report).

NTIS Number: N89-24316/6/XAB; Diverter AI (Artificial Intelligence) Based Decision Aid, Phases 1 and 2 (Final Report).

NTIS Number: N93-28852/0/HDM; Planning for Air to Air Combat.

NTIS Number: N92-27899/3/HDM; Technology and Standards for a Common Air Mission Planner.

AF95-157 TITLE: Measure Aircraft Tire Tread Wear and Runway Microtexture

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Design Automation

OBJECTIVE: Develop Technology and Hardware To Measure Aircraft Tire Tread Wear and Runway Surface Micro Texture.

DESCRIPTION: Runway texture, aircraft speed, camber, yaw, chemical composition of the tread, temperature, etc., affect tread wear. At the present time, tread health is known from visual observation and tread wear is measured manually. This is a very time consuming and labor intensive process. The program calls for the development of technology and hardware where tread and runway microtexture would be measured automatically, remotely and expeditiously. Knowledge of tread health will dictate actual service time instead of the periodic scheduled maintenance, thus saving labor and cost. Knowledge of microtexture and runway profile will help avoid any dynamic load spikes to the landing gear and aircraft resonance speeds.

PHASE I: Technology will be developed to cover the concept feasibility and initial hardware to measure static tread health, remotely, and autonomously. Similar technology will be developed to measure runway texture and surface profile.

PHASE II: This will cover the development of the final product and future improvement to measure the tire tread state in a dynamic case.

COMMERCIAL POTENTIAL: Military & Civilian Aircraft Industry and Automotive Industry.

REFERENCES:
NTIS Accession Number: AD-B177 539, "The Improved Tire Life Program," (Interim rept. May 91-May 93).

ASTM STP 929, "The Most Complex Tire-Pavement Interaction: Tire Wear," Veith, A.G., The Tire Pavement Interface, M.G. Pottinger and T.J. Yager, Eds., American Society for Testing Materials, Philadelphia, 1986, pp. 125-158.

AF95-158 TITLE: Low Cost Advanced Composite Processing for Spacecraft Application

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop low cost, quickly manufactured composite processes for either carbon-carbon or organic matrix composites.

DESCRIPTION: Spacecraft require dimensionally stable, lightweight materials for space subsystems (phased array antenna backup structures, spacecraft bus structures, solar power backup structures) and advanced thermal management systems (electronic packaging, battery sleeves, thermal doublers, radiators, etc.). These systems will require new materials to be developed to maintain high pointing accuracy requirements. Thus, these materials must be (1) dimensionally stable, which require a high stiffness to resist thermal strain; highly conductive to reduce temperature drops across the structure; a near zero coefficient of thermal expansion to minimize thermal strain; and a high specific stiffness to increase the natural frequency of vibration and (2) lightweight to minimize launch costs. The use of advanced carbon-carbon or organic matrix composites such as cyanate esters satisfy these requirements. Novel processing approaches for either organic matrix composites or carbon-carbon composites are encouraged. For carbon-carbon composites, innovative, low cost, quickly manufactured processes are encouraged. Currently, the cost of high modulus or high conductivity composites is dominated by the cost of graphite fibers (up to 85%). Enormous cost reductions in making high conductivity carbon-carbon may be possible using copyrolisis techniques. Organic matrix composites offer weight savings over conventional materials with competitive costs. Some of the challenges of such materials for space applications include low thermal distortion, high stiffness, long-term stability under the space environment, and thermal conductivity. Materials that meet these challenges must also be robust in processing. Innovative processes may be utilized to better meet the challenges, such as non autoclave curing. Resins that enable such processes could greatly reduce the risk of application and, therefore, reduce structural weight. Fibers of high compressive strengths, yet high stiffness, and balanced

tensile strengths enable designers to use composites in demanding structural applications. Material systems that incorporate conductive resins or combinations of structural and thermal fibers may reduce overall spacecraft costs by reducing the need for costly heat pipes.

PHASE I: Will consist of parametric proof-of-concept studies using small coupon-level articles to demonstrate the viability of the process.

PHASE II: Will develop and characterize the process demonstrated in the Phase I effort.

COMMERCIAL POTENTIAL: All composite material processes will have direct application in commercial spacecraft. Moreover, the thermal management materials will have application in commercial airplanes.

REFERENCES:

1. Buckley, John D., "Carbon-Carbon, An Overview," Ceramic Bulletin, Vol 67, No.2, 1988. Diefendorf, Russell J., "Continuous Carbon Fiber Reinforced Carbon Matrix Composites."

2. Engineered Materials Handbook Composites, Donnet, Jean-Baptiste and Roop C. Bansal, Carbon Fibers, 2nd Ed, New York: Marcel Dekker, Inc., 1990.

3. Fitzer, Erich, "The Future of Carbon-Carbon Composites," Carbon, Vol 25, No. 2, 1987.

AF95-159 TITLE: Barium Free Corrosion Inhibited Hydraulic Fluids

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop non barium containing corrosion inhibited hydraulic fluids for Air Force and DOD use.

DESCRIPTION: The Air Force is interested in the research and development of environmentally compliant replacements for barium in hydraulic fluids since barium is a hazardous material. A need exists to develop corrosion inhibitor candidate additives to replace the barium dinonylnaphthalene sulfonate currently used in Air Force and DOD hydraulic fluids. New environmentally compliant corrosion inhibitor (replacement) candidate additives will be developed. The rust inhibiting effectiveness of these candidate additives will be determined in both the mineral oil based and the polyalphaolefin based hydraulic fluids. The more promising formulations will be evaluated against current military specifications to verify an equivalent performance or better can be achieved with the new corrosion inhibitors. The materials must meet the requirements for compatibility with current systems while minimizing their impact on the environment. Final validation of the new formulations will be accomplished by hydraulic pumps tests in aircraft hydraulic pumps.

PHASE I: Develop a list of possible candidate (non barium) fluid additives to meet the goals of the program. Address initial evaluation and formulation of specific fluid additives to achieve these goals.

PHASE II: Further develop and optimize the fluid additives demonstrated in Phase I and produce larger samples for more detailed evaluations.

COMMERCIAL POTENTIAL: Large commercial potential for non-DOD aircraft (e.g., small commercial aircraft) and dual use potential to eliminate a known hazardous material from the environment.

AF95-160 TITLE: Improved Thermal Control Coatings for Spacecraft

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop a space stable material to provide thermal control for spacecraft radiators.

DESCRIPTION: Thermal control on spacecraft is accomplished by the use of surfaces which are optically tailored to reflect the sun while emitting excess spacecraft heat to space in the infrared. There exists the need to improve the state of the art in radiator coating performance, as well as develop coatings that are applicable to new materials (i.e., high conductivity Carbon-Carbon (C-C) composites). Develop a very low a/e sprayable coating system which is readily deposited over large areas, is compatible with a wide variety of substrate materials (including Aluminum and C-C composites), provides optical performance similar to Quartz Optical Solar Reflectors (OSRs) at a far lower cost, and is stable in the space environment. Demonstrate the ability to reproducibly apply the coating system to complex surfaces (curves).

PHASE I: Attain solar absorptance, $a < = 0.10$, thermal emittance, $e > = 0.90$

PHASE II: Demonstrate the coating system applicability, stability (Goal: Change in solar absorptance, $\Delta a < 0.15$), and reproducibility. Produce test samples for industry evaluation. Prepare transition and commercialization plan for the coating system.

COMMERCIAL POTENTIAL: Material will be available for non-DOD spacecraft (e.g. any commercial communication satellite) applications. Material may have potential alternate (nonspacecraft or thermal control) applications.

REFERENCES:

DTIC accession number DF501309, "Radiation Stable Coatings for Temperature Control of Satellite Systems and Associated Critical Temperature Sensitive Components."

DTIC accession number DF376074, "Space Environmental Effects."

AF95-161 TITLE: Optical Signature Control Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop innovative materials for controlling the optical signatures of aircraft.

DESCRIPTION: The Air Force is interested in conducting exploratory development of innovative materials for controlling the optical signature of aircraft. Material systems of interest include, but are not limited to, paints and their constituents (binders, pigments, etc.) as well as appliques or other surface treatments capable of modifying the aircraft optical signature in a desirable manner. Investigations may include bulk material properties and/or novel concepts based on combinations of constituent materials in some unique construction. The materials should address the following areas of concern: -Optical Properties: The materials must be capable of controlling the optical signature of aircraft. Specifically, research shall involve controlling emissivity/reflectivity in the ultraviolet, visible, and infrared regions of the electromagnetic spectrum. At the current time, the infrared bands are the highest priority. -Environmental: The materials (and application process) selected for development should minimize adverse environmental effects. For example, paints should be low/zero VOC (volatile organic compounds) and pigments should minimize hazardous components (lead, chromates, etc.). -Durability: The materials must provide sufficient durability to survive in an aerospace environment. -Affordability: The overall cost of optical signature control materials should be minimized.

PHASE I: Phase I will include initial formulation and fabrication of materials. A preliminary evaluation of the optical and physical/durability properties will be made.

PHASE II: Phase II will further develop and optimize the materials and produce larger samples for a full spectrum of evaluations.

COMMERCIAL POTENTIAL: Opportunities for commercialization exist in the areas of solar energy and satellite thermal control. Commercialization of the technology would involve scale-up to production capacity, and production of sufficient quantities of material to coat aircraft or other large objects using an environmentally compliant and commercially viable application technique.

REFERENCES:

AFWAL-TR-86-1028, "Camouflage Handbook," April 1986.

AF95-162 TITLE: Aging Systems Nondestructive Evaluation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Development of new nondestructive inspection/evaluation techniques for aging aerospace systems.

DESCRIPTION: Advanced innovative approaches are needed for the development of new and improved nondestructive inspection and evaluation (NDI/E) techniques for the detection, imaging, and characterization of flaws and other integrity-reducing anomalies in aging flight vehicle and engine components. In particular, innovative technical approaches are needed for (a) the detection and characterization of metal corrosion in hidden/inaccessible airframe locations before significant materials loss has occurred, (b) the detection and characterization of cracking/multisite damage in metallic airframe structures, (c) the characterization and qualification of advanced materials for use in the repair and retrofit of aging systems, and (d) the

detection, imaging, and characterization of surface and bulk anomalies in metallic and nonmetallic airframe structures or engine components. Technical approaches proposed must either achieve clearly significant improvements in the standard techniques currently being used in factory and/or Air Force Air Logistics Center inspections, or must identify new inspection and evaluation technologies which have capabilities far superior to those currently used and which have the clear potential for ultimate use in realistic manufacturing or in-service environments.

PHASE I: This program will address the initial formulation, fabrication, and evaluation of specific NDI/E techniques for demonstration of proof of concept.

PHASE II: This program will perform enhanced development for optimization of the NDI/E techniques investigated in Phase I.

COMMERCIAL POTENTIAL: The developed approaches would have commercial (e.g. airline engines) applicability due to the large number of commercial aircraft and engine systems that have problems of a very similar nature to those faced by the DoD.

AF95-163 TITLE: High Temperature Structural Materials for Advanced Air Force Systems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop and characterize advanced high temperature structural materials.

DESCRIPTION: New approaches are requested to develop and characterize (a) advanced high temperature structural ceramic composites (2000° F to 3500° F, excluding carbon-carbon composites), (b) intermetallic materials and composites (2000° F to 3000° F, excluding nickel aluminides and discontinuously reinforced titanium aluminides), and (c) model forming processes for advanced structural materials. For ceramic composites, research is limited to continuous ceramic fiber reinforced ceramic matrix systems and may include the following: (a) new, unique ceramic composite development; (b) fiber/matrix interface treatments engineered for toughened behavior and stability; (c) continuous ceramic fiber development; (d) test techniques to determine mechanical and physical behavior (such as failure modes, crack and void growth, oxidation, stress-strain, cyclic stress-strain, etc.) as a function of temperature and loading history; and (e) analytical modeling of composite behavior. For intermetallic materials, research is limited to (a) new or novel methods for synthesis and processing of composites for intermetallic alloys which emphasize achieving theoretical density, low defect and interstitial content, and low synthesis temperature; (b) methods for modeling intermetallics and intermetallic composites which lend insight into chemistry selection and control as well as microstructural selection and control; (c) methods of fabricating composites to provide chemistry and microstructural control on a submicron scale while maintaining the ability to vary and control the final microstructural scale; and (d) methods for environmental protection of intermetallic composites aimed at providing long life under cyclic oxidation conditions. For modeling of forming processes, research may include modeling of (a) the unit forming process; (b) the material behavior in response to the demands of the unit process; (c) the interface between the work piece and the die or mold; and (d) novel methods for obtaining physical property data and constitutive equations for insertion in models.

PHASE I: This program will focus on the critical issues which when solved, will provide proof of concept.

PHASE II: This program will be structured to develop and refine those feasible concepts to the point where an assessment could be made of the ultimate potential to help meet Air Force advanced materials needed.

COMMERCIAL POTENTIAL: The developed approaches would have broad commercial applicability due to the large number of commercial aircraft and engine systems that have materials requirements of a very similar nature to those faced by the DoD. Various energy conservation applications, e.g., radiant burners, heat exchanger, and power turbines, are also pertinent.

REFERENCES:
"Ultrahigh Temperature Assessment Study - Ceramic Matrix Composites," E.L. Courtright, H.C. Graham, A.P. Katz, and R.J. Kerans, WL-TR-91-4061, Materials Directorate, Wright Laboratory, Air Force Materiel Command, Wright-Patterson AFB, OH, September 1992.

AF95-164 TITLE: Novel Materials & Processes for Nanostructures, Electronic, and Optical Applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Obtain new materials and/or processes that permit the construction of devices that diminish optical radiation.

DESCRIPTION: The Air Force is interested in research and development projects directed toward potential applications of nanotechnology to optical limiting and commercial requirements. Such a program should address the fabrication of materials with compositions and/or microstructural morphologies of such complexity that offer desirable properties for use in nanoscale devices such as, but not limited to, micro-electro-mechanical systems (MEMS). The study of this area could conceivably lead to the development of processing and materials with electronic and electro-optical properties and that also contain very few microstructural anomalies. Since nanoscale materials could conceivably perform several functions, e.g. a photoresist can also remain as a mechanical element, an investigation of the trade-offs involved in material systems could lead to a design philosophy for multifunctional materials with, for example, both optical, electro-optical and structural properties. Special consideration will be given to those proposals that address processes that have both military and civilian applications, i.e., dual usage.

PHASE I: Programs in these areas should address the requirements and goals of the proposed efforts, as well as initial formulation, fabrication, and evaluation required for proof of concept.

PHASE II: The process or design concepts from Phase I would be developed through optimization and scale-up efforts to establish feasibility for manufacture. Either process or design concepts would lead to a marketable product after a Phase III program.

COMMERCIAL POTENTIAL: The potential applications of this technology could apply to telecommunication and medical prosthetic devices.

REFERENCES:

1. IEEE Solid-State Sensor & Actuator Workshop, Hilton Head Island, South Carolina, 22-25 June 1992, IEEE Catalogue #92TH0403-X.

2. Proceedings of IEEE Micro-Electro-Mechanical Systems Workshop, Fort Lauderdale, Florida, 7-10 February 1993, IEEE Catalogue #93CH3265-6.

3. Micro- & Nanotechnology for Space Systems: An Initial Evaluation, edited by H. Helvajian & E.Y. Robinson, The Aerospace Corporation, El Segundo, California, Aerospace Report No. ATR-93(8349)-1.

4. Journal of Micromechanics and Microengineering, Institute of Physics Techno House, Redcliffe Way, Bristol BS1 6NX, United Kingdom.

5. Journal of Micromechanical Systems, Joint IEEE/ASME Publication, IEEE Headquarters, 345 47th Street, New York, NY 10017.

AF95-165 TITLE: Nonlinear Optical Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop nonlinear optical materials with superior properties as compared to those presently available.

DESCRIPTION: Nonlinear optical (NLO) materials are required for a variety of Air Force applications including electro-optic countermeasures, LIDAR, laser radar, optical signal processing, and optical interconnects. These applications require new laser sources (optical parametric oscillators and harmonic generators) and electro-optic devices (directional couplers, guided-wave interferometers, and spatial light modulators). However, presently available materials are unsatisfactory for many applications due to small nonlinearities, poor optical clarity, long response times, difficulty in processing for devices, and other factors. Proposed efforts shall address inorganic or organic materials in bulk or thin-film forms which exhibit large second-order nonlinear effects. Innovative techniques for preparing new materials or for improving the growth or processing of known materials are encouraged. Nonlinear optical devices may be examined only as a minor part of a materials effort for the purpose of evaluating and demonstrating the properties of the material(s).

PHASE I: The objective is to demonstrate the proposed growth or processing techniques.

PHASE II: The objective is to develop advanced nonlinear materials and relevant processes to demonstrate potential.

COMMERCIAL POTENTIAL: Materials technology is fundamental to all applications, military and commercial. Examples of commercial applications for NLO bulk crystals are LIDAR for environmental monitoring, medical lasers, and scientific instruments. Examples for NLO thin films are optical interconnects for electronic chips and packages, switching networks for communications, and automatic object recognition systems.

REFERENCES:
1. Bordui, Peter F. and Martin M. Fejer, "Inorganic Crystals for Nonlinear Optical Frequency Conversion," Annual Review of Materials Science (Volume 23), ed. Robert A. Laudise et al. Annual Reviews Inc, 1993.

2. Dmitriev, V.G., G.G. Gurzadyan, and D.N. Nikogosyan, Handbook of Nonlinear Optical Crystals. Springer-Verlag, 1991.

3. Baumgartner, R.A. and R.L. Byer, "Optical Parametric Amplification." IEEE Journal of Quantum Electronics QE-15 (1979), pp. 432-444.

4. Fejer, Martin M. et al., "Quasi-Phase-Matched Second Harmonic Generation: Tuning and Tolerances." IEEE Journal of Quantum Electronics QE-28 (1992), pp. 2631-2654.

5. Lackritz, Hilary S. and John M. Torkelson, "Polymer Physics of Poled Polymers for Second-Order Nonlinear Optics," Molecular Nonlinear Optics. Academic Press, 1994.

AF95-166 TITLE: Growth of Bulk III-V Semiconductor Ternary Alloys

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop a production scaleable growth technique for bulk III-V semiconductors.

DESCRIPTION: Ternary alloys are used extensively in devices, but due to the unavailability of ternary substrates (InGaAs, AlGaAs, GaInSb, etc.), these layers must be grown on binary wafers (GaAs, InP). This limits crystal quality for thick films and the ultimate device performance, particularly noise, power and frequency. Ternary substrates provide more flexibility in the materials that can be grown and provide higher quality epitaxial layers. These improved materials properties translate into lower noise microwave and millimeter wave devices (noise figures about half that of GaAs). Higher operating frequencies are also enabled by these materials (~ 1.8 X GaAs). The goal of this program is to develop innovative and creative solutions to problems in the area of ternary semiconductor crystal growth, with a practical growth technique (suitable for commercial production) resulting.

PHASE I: The goal for Phase I is to demonstrate a production scaleable process for the growth of ternary bulk III-V semiconductor crystals suitable for use as substrates.

PHASE II: During Phase II, the contractor shall perform process optimization, scale-up and plan for Phase III commercialization. Technical and economic issues impeding the successful development of the technology developed during Phase I should also be addressed.

COMMERCIAL POTENTIAL: As with all electronic materials, ternary III-V semiconductor substrates have numerous commercial applications. Since these materials aren't currently available, these materials are not presently used in commercial products. With a production scale process, however, materials would be available allowing for the commercial development of low noise, high frequency devices for use in personal communications and automotive electronics.

REFERENCES:
"Mechanical Properties of Semiconductors and Their Alloys," SRI Inc, DTIC AD No: A231820.

AF95-167 TITLE: High Temperature Superconducting Thin Films

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop advanced thin film processes to enable fabrication of HTS devices for electronic, microwave and opto-electronic applications.

DESCRIPTION: High temperature superconducting (HTS) thin films offer a variety of application opportunities. For example, low-loss broad band microwave circuits, improved infrared sensors, higher density interconnects, and faster signal processing can potentially be achieved. In order to fully utilize the value of HTS technology, the properties of the materials and the interfaces between materials must be controlled. Examples of topics considered appropriate for this program area are the development of reproducible thin film deposition and processing methods for fabrication of superconductor-insulator multilayers, for fabrication of SNS or SIS junctions with optimized characteristics, or for integration of HTS materials with semiconductor

technologies. This topic addresses the development of materials and processing techniques which shall make practical use of superconducting materials in various electronic applications possible. Devices may be examined only for the purpose of evaluating and demonstrating the techniques and materials which have been developed in order to enable successful fabrication of the devices.

PHASE I: Phase I will address process development and initial testing to demonstrate proof of concept. Delivery of a representative test sample or samples to the government is encouraged.

PHASE II: Phase II will develop and optimize the process or material to demonstrate the potential application and will plan for Phase III commercialization. Delivery of material samples to the government for testing is encouraged.

COMMERCIAL POTENTIAL: HTS materials technology has great potential for dual use and commercial applications. For example, passive millimeter wave components fabricated with HTS thin films offer significant savings in weight and size for commercial communication satellites. HTS materials may also be used in commercial electronics applications to provide improved multichip modules and faster signal processing.

REFERENCES:
"Demonstration of YBaCuO and Complementary Metal-Oxide-Semiconductor Device Fabrication on the Same Sapphire Substrate," M.J. Burns et al., Applied Physics Letters 63, 1282 (1993). DTIC accession number is AD-A273119.

AF95-168 TITLE: Enzyme Activated Aircraft Coatings Removal

CATEGORY: Basic Research
DOD TECHNOLOGIES: Industrial Production

OBJECTIVE: To develop an enzyme system which attacks typical aircraft coatings to facilitate their removal during maintenance.

DESCRIPTION: Traditional aircraft coatings removal processes have relied heavily on solvent based chemical strippers that contain EPA listed hazardous air pollutants (HAPs). By 1996, these materials will be virtually banned from use in airframe coatings removal processes. Alternative processes, such as abrasive blast stripping, can damage delicate aircraft structures and components such as thin or honeycomb skin, composite materials, and radomes. Enzymes which catalyze the degradation of polyurethane or other typical aircraft coating chemistries could be formulated into an efficient, nonhazardous, brush-on coatings remover which does not damage sensitive substrates. This research would identify, isolate, and produce enzymes or synthetic analogs that are active in polyurethane degradation. These catalysts would then be incorporated into a brush-on stripper formulation.

PHASE I: The goal of Phase I is to identify and isolate one or more enzymes which is active in degrading cured, aged polyurethane aircraft coatings and to clearly demonstrate this degradation.

PHASE II: Candidate enzymes will be further developed and optimized in Phase II. This phase will include scale-up of production of enzymes and incorporation into a brush-on, room temperature coatings remover formulation. This phase will demonstrate removal of polyurethane based aircraft coatings from panels prepared in accordance with USAF standards, without damage to the substrate. A prototype enzyme activated coatings remover will be the end product of Phase II.

COMMERCIAL POTENTIAL: An enzymatic polyurethane coatings remover would have broad commercial applications for use as an environmentally friendly method of removing aircraft or automotive finishes, and cleaning of polyurethane molding and painting equipment. This enzyme could also be used to accelerate the degradation of polyurethane plastic wastes in landfills.

REFERENCES:
"The Mechanisms of Biodegradation of Synthetic Polymers," Cameron, J.A. and S.J. Huang, DTIC AD#A205628.

AF95-169 TITLE: Structural Integrity Analysis of Failed Composite Components

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop a user-friendly computer program to analyze the structural integrity of composite components.

DESCRIPTION: Currently, there are no available computer programs which generically, and very efficiently, calculate the strength and stiffness of all types of composite components. Investigations of damaged composite structure require not only material and fractographic analysis but structural analysis as well to identify the cause of failure. Availability of a program that

provides a quick assessment of the structural integrity of composite components is needed to preclude recurrent failures. In the past, contractor support has been used for these analyses; however, the contractor's analyses are generally component specific and often need to be modified and revised to account for deficiencies noted during the investigation. In order to conduct a complete, and unbiased failure investigation, it is imperative that a computer program be available to the Air Force which quickly and efficiently calculates the structural integrity of all types of composite components, both with and without defects. The main goal of this program is to conduct thorough analyses of failed components obtained from both new and aging aircraft.

PHASE I: Phase I would result in an innovative, user-friendly program for the analysis of strength and stiffness for various geometric composite shapes of in-service structures, including, but not limited to, box beams, I-beams, C-channels, truss, tubular, honeycomb, and adhesively bonded structures.

PHASE II: Phase II would develop a user-friendly program to account for various stress concentrations and defects in composite materials, including, but not limited to bolted joints, ply drop-offs, high void content, drilled holes, internal and edge delaminations, and environmental influences.

COMMERCIAL POTENTIAL: This program should result in a program which could be utilized by the National Transportation Safety Board in their analysis of failed commercial aircraft structures. Additionally, the analyses should also be adaptable to composite construction, such as bridges, as well as recreation equipment manufactured from composite materials.

REFERENCES:
1. Kar, R.J., "Composite Failure Analysis Handbook," DTIC Numbers: ADA 250520, ADA 250521, ADA 249130, ADA 249131.

2. Ashton, J.E., Burdorf, M.L., and Olson F., "Design, Analysis, and Testing of an Advanced Composite F-111 Fuselage," Composite Materials: Testing and Design (Second Conference), ASTM STP 497, ASTM, pp. 3-27 (1972).

3. "Simplified Design Procedures for Fiber Composite Structural Components/Joints," NASA TM-103113.

AF95-170 TITLE: Life Prediction of Aging Aircraft Wiring Systems

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Characterize wiring system aging phenomena and develop life prediction models based on operational use.

DESCRIPTION: Wiring systems have traditionally been responsible for high maintenance rates on aircraft and significant contributors to aircraft mishaps. The increasing emphasis on electronics has made electrical distribution a critical aircraft system. A scientifically based approach for ascertaining when to replace wiring in aging military and commercial aircraft currently does not exist. Replacement costs can be considerable and failure to replace aged or degraded wiring can lead to serious mishaps. Wiring systems typically consist of insulation materials, conductors, and connectors. To reduce weight and volume, wiring systems are made-up of thin walled polymer materials that provide electrical insulation and small diameter, low resistance, high strength conductors. Typical wiring problems include (not in order of importance) chafing or mechanical damage, degradation due to thermal effects and chemical attack, electrical breakdown, conductor corrosion, thin film formation on contacts, and various manufacturing defects. Many of the above problems and other important wiring properties can be related to time, temperature, and stress. A model that incorporates wiring system degradation effects and ultimately life prediction is desired. The model should be based on materials currently in use on aircraft systems. Destructive and nondestructive methods for evaluating the remaining life of the wiring system would also be required.

PHASE I: The goals of a Phase I program are to identify critical aircraft wiring properties, relate wiring problems to specific failure mechanisms, and demonstrate that a time, temperature, and stress model can be developed. A fighter aircraft is suggested as a candidate for assessing wiring requirements, materials, and overall stress environment.

PHASE II: A Phase II effort would be expected to develop a computerized life prediction model capable of determining the useful life of a wiring system given materials, property requirements, and environmental stress levels. Techniques for detecting identified wiring system life-limiting characteristics would also be expected.

COMMERCIAL POTENTIAL: A successful life prediction program could also be applied to commercial aircraft. A similar approach could also be used for other electronic systems either in aircraft or ground systems.

REFERENCES:
New Insulation Constructions for Aerospace Applications, Volume 1 (AD-A240638). Failure Analysis Techniques for the Evaluation of Electrical and Electronic Components in Aircraft and Accident Investigations. Insulation Life Studies (DN291124) and (DN156255).

AF95-171 TITLE: Pollution Prevention Techniques for the Production of III-V Semiconductor Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop innovative techniques and processes for reducing hazardous materials in the production of III-V semiconductors.

DESCRIPTION: The III-V semiconductor materials include gallium arsenide (GaAs) and indium phosphide (InP), both of which require the use of extremely hazardous materials for production. As military needs shift toward higher-performance electronic materials, there will be increased dependence on GaAs and other III-V semiconductor devices. There are many areas along the growth process route where pollutants are generated, and with increasingly stringent hazardous materials regulations, the semiconductor production process is at risk. For this program, innovative and creative solutions are requested addressing pollution prevention in the production of III-V semiconductor materials. Proposals should identify a significant source of pollution in the production of III-V semiconductor materials (may be bulk or epitaxial processes), and propose a solution. Emphasis should be placed on the development of practical, cost effective solutions, and involvement of industrial partners is encouraged. A clear transition plan to Phase III commercialization should be presented.

PHASE I: The goal of Phase I is to identify a significant source of pollution (solid, liquid or effluent) and demonstrate a practical solution to reducing the amount or toxicity of pollutants generated. The proposed solution should be directly applicable to existing semiconductor industry growth techniques (such as MOCVD, MOMBE, etc.) or be of a nature that no major re-tooling would be required by an industrial customer. At the end of Phase I, this technique will have demonstrated the capability to reduce the quantity and/or toxicity of pollutants generated in a semiconductor material growth process.

PHASE II: During Phase II, the contractor shall perform process optimization, scale-up and plan for Phase III commercialization. Technical and economic issues impeding the direct insertion of technology developed into existing semiconductor growth processes should also be addressed.

COMMERCIAL POTENTIAL: Military applications account for less than a third of the present III-V semiconductor device market. The growing personal communications industry (cellular phones) relies on GaAs technology. There are also many new commercial applications for X-band radar devices being explored, including collision avoidance radar for automobiles. InP-based technology also has a wide range of commercial applications, although they are not widely marketed at present. Opto-electronic and photonic applications, as well as opto-electronic integrated circuits (OEICs) hold great promise for future commercial development.

REFERENCES:
"Proceedings of the Annual Conference on Environmental Toxicology," DTIC AD No: A178248.

AF95-172 TITLE: Environmentally Compliant Coatings

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop low/zero-VOC materials and/or application techniques suitable for aircraft coatings.

DESCRIPTION: The Air Force is interested in the research and development of aircraft coatings with a minimal detrimental impact on the environment. Most conventional coating application systems currently in use produce substantial organic solvent emissions. Some include toxic, noxious, or smog producing components. New materials and/or application systems that can greatly reduce or eliminate these VOCs (Volatile Organic Compounds) and other undesirable materials are necessary in order to comply with stringent environmental regulations, either currently in effect or likely to be enacted in the near future. Relevant technologies for low/zero-VOC coating development include, but are not limited to, high solids coatings, waterborne coatings, powder coatings, plasma/thermal spray systems, and appliques. Innovative materials, such as binders, pigments, thin films, and their suitability for use in these types of application systems are also of interest.

PHASE I: Phase I will address initial formulation, fabrication, evaluation, and application techniques of specific subjects for proof of concept.

PHASE II: Phase II will further develop and optimize the material and/or application techniques, and produce larger samples for a full spectrum of evaluations.

COMMERCIAL POTENTIAL: The requirement to comply with environmental regulations applies equally to the commercial coating industry. As such, much of the technology developed for compliance of military coating systems could be extended to

commercial applications. Commercialization of the technology would involve scale-up to production capacity, and production of sufficient quantities of material to coat aircraft or other large objects using an environmentally compliant and commercially viable application technique.

REFERENCES:
Title I of the Clean Air Act Amendments of 1990 (CAAA) California South Coast Air Quality Management District Rule 1124

AF95-173 TITLE: Environmentally Compliant Corrosion Inhibitors for Aerospace Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop and test environmentally compliant corrosion inhibitors that meet corrosion requirements for aerospace coating materials.

DESCRIPTION: The U.S. Air Force is interested in the research and development of non-chromated corrosion inhibitors that are nontoxic and environmentally compliant and provide the level of corrosion protection that we currently have, if possible, with chromated corrosion inhibitors. These new compliant inhibitors are to be used in coatings/paints that are used on transport and fighter aircraft. The inhibition mechanisms of these new inhibitors are to be studied and verified so that the U.S. Air Force fully understands the ability of these compounds to inhibit corrosion and their effects on aging aircraft issues. Field studies are to be undertaken as well as accelerated laboratory testing to correlate field and laboratory test results.

PHASE I: Identify, develop, and evaluate new environmentally compliant corrosion inhibitors that would provide corrosion protection for aircraft materials. This effort would include developing and identifying tests methods that ensure inhibition properties are fully understood and evaluated. Formulation requirements of these materials in coatings such as polyurethane and epoxy based materials are to be developed and verified.

PHASE II: Further develop and optimize the inhibitors and formulation requirements for polyurethane and epoxy based coatings. Provide quantities and formulations for field testing and extensive laboratory tests.

COMMERCIAL POTENTIAL: The need to comply with environmental regulation and reduce toxic waste is of the utmost importance in commercial and military industries. Military aerospace materials are extensively used by the commercial aerospace industry as well as other select industries in need of high performance materials. The commercialization of this technology would readily transfer to civilian companies.

REFERENCES:
The 33/50 Program, The Office of Toxic Substances, The United States Environmental Protection Agency.

AF95-174 TITLE: Innovative Control Architectures, Sensors and Applications for Pulsed Laser Deposition (PLD)

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Investigate control architectures, sensors and applications for Pulsed Laser Deposition to autonomously deposit thin films.

DESCRIPTION: Currently pulsed laser depositions are conducted in an open-loop environment. In closed-loop operation, a recipe generates a film with no feedback from sensor data to adjust the laser parameters. This open- loop approach has low deposition rates and generates films of inconsistent quality. While great strides are being made in developing different film compositions, the film characteristics cannot be completely explored given the lack of precise film composition and film quality. A self-directed control architecture and sensors would allow the integration of sensor data into a knowledge base that adjusts laser parameters to generate superior thin films. In Phase I, potential PLD deposition applications are to be investigated. Possible applications include, but are not limited to, solid lubricous coatings, hard coatings, diamond like coatings and superconducting thin films. Phase II will continue by investigating and developing promising control architectures, sensors and applications.

PHASE I: Goal: Identify potential PLD applications.

PHASE II: Work to be performed: Investigation and development of promising control architectures, sensors and applications. Development of a preliminary prototype.

COMMERCIAL POTENTIAL: Dual use of this exploratory research is foreseen for PLD process control in development of superconducting thin films, lubricous coatings for vacuum applications, and hard coatings for machine dies and tool bits.

REFERENCES:

Stark, E.F., & Laube, S.J.P., Self-Directed Control of Pulsed Laser Deposition, Journal of Materials Engineering and Performance, Volume 2(5) October 1993, published by ASM International pp. 721-726.

AF95-175 TITLE: Knowledge Base Development Tool for Materials & Processing Discovery

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop automated tool and reading databases to build materials and process knowledge bases and models.

DESCRIPTION: Currently approaches to modeling materials include, depending on the profiles of interest, calculations from first principles, continuum models, and macrobehavior models. The massive computation requirements in terms of time and therefore cost significantly limit the usefulness of these approaches. Further, although progress is being made, the widespread application of these approaches is precluded because of the difficulty in applying quantum mechanical equations to materials of engineering interest. An alternative approach would peruse and/or explore experimental data to discover patterns that can be used as predictors of mechanical, crystallographic, and thermodynamic behavior. Knowledge base development tools are needed which invoke methods such as neural nets, genetic algorithms, associative memories and other computational methods. In Phase I , investigations will be accomplished to determine the limits of existing methods in modeling materials and what new methods may have to offer. Materials of immediate interest include high temperature intermetallics, composites, electro-optical semiconductors, and polymers.

PHASE I: Goal: Identify limits of existing methods in modeling materials and determine what new methods may have to offer.

PHASE II: Continue the investigation of promising knowledge base development tool approaches, emphasizing their application to specific materials.

COMMERCIAL POTENTIAL: Dual use of this exploratory research is foreseen for process design of microchips and other microelectronic devices, machining and inspection of structural parts, and design of high performance metals, ceramics, and polymers.

REFERENCES:

Woods, D., & Park, J., Discovery Systems for Manufacturing, WL-TR-94-4008.

AF95-176 TITLE: More Electric Aircraft Power System Technologies

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Explore and develop electrical components, devices, and systems applicable to future and retrofit "more electric" aircraft.

DESCRIPTION: Proposals should address enabling technologies required to develop, test, and integrate a more electric aircraft. Under more electric aircraft concept, secondary power systems traditionally powered by a hybrid of centralized hydraulic, pneumatic, mechanical, and electrical subsystems are replaced by highly reliable electrically based power systems. These systems include electrical power generation, distribution, utilization, and energy storage. Key technology barriers to overcome are fault tolerance, thermal management, electrical control and regualtion, electromagnetic compatibiity, fault detection, and integration.

PHASE I: Phase I goals include analyses and proof-of-concept experiments.

PHASE II: Phase II goals include demonstration of flight qualified, flight ready hardware.

COMMERCIAL POTENTIAL: More Electric Aircraft technologies have civilian application on aircraft, ground vehicles, ships, and rotorcraft. Electrical power technologies are also applicable to power generation, motors, switching, and actuator industries and their manufacturers.

REFERENCES:

"Electrical Power Technology for the More Electric Aircraft," Proceedings of 12th Digital Avionics Systems Conference, AIAA/IEEE, ISBN 0-7803-1343-7, 1993, pg 445-450.

AF95-177 TITLE: Power Electronics Devices, Components and Subsystems

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion

OBJECTIVE: Explore and develop power electronic devices, components, and subsystem for future 1 kW-150 kW aeronautical electrical power system applications.

DESCRIPTION: Proposals should address the development of power electronic semiconductor devices, passive components (capacitors, inductors, dielectrics, hard and soft magnetics) and subsystems for aeronautical power system applications (such as motor drives, inverters, and converters) in the power range of 1 kW to 150 kW. Candidate device, component and subsystems technologies should demonstrate advancements in efficiency, power density, and/or higher temperature capability greater than 200 degrees C. Improvements in thermal management, reliability and acquisition cost are also of interest.

PHASE I: Phase I goals include analyses and proof-of-concept experiments.

PHASE II: Phase II goals include detailed analytical deviations and prototypical devices, components, or hardware demonstrations.

COMMERCIAL POTENTIAL: Much of the technology is of direct interest to future commercial utilization by the electric and hyprid electric vehicles, pwer generation, motor drive industry.

REFERENCES:
"Principles of Solid-State Power Conversions," Tarter, Ralph E., TK7881.15.T36, 1985.

"Power Integrated Circuits: Physics, Design;" New York: McGraw Hill c 1986, TK7881.15, P68 1986.

AF95-178 TITLE: Physics of Plasma Processing

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Explore and characterize the physics fundamentals governing thin films and nucleation produced by plasma-enhanced deposition.

DESCRIPTION: Proposals should address plasma processing and plasma-enhanced deposition science which is used in making diamond, diamond-like thin films, and other wide bandgap materials for power semiconductors, thermal control surfaces and mechanical surface treatments. These fundamentals also apply to disposal of hazardous substances. Proposals should focus on those aspects of the deposition process which will have direct transfer applicability to commercial processes.

PHASE I: Phase I efforts will focus on identifying physical mechanisms and limitations governing important interfaces and their processing parameters (e.g., uniformity, topography, rates of deposition, defects, and economic scaling to larger areas and novel materials) related to the plasma, surface interaction problems.

PHASE II: Phase II efforts will focus on demonstrating process control and validating improvements. Phase III efforts will demonstrate specific device applications of the improved plasma processing.

COMMERCIAL POTENTIAL: Plasma deposition processes are pervasive in the commercial semiconductor industry. Along with deposition processes for semiconductors, commercial application of these processes for applying coatings and insulation are important.

REFERENCES:
"The Importance of Vibrationally Excited Nitrogen in Silicon Nitride Deposition Systems," Lawrence G. Piper, Physical Sciences, Inc., WL-TR-93-2097, DTIC AD No.A274874.

"Laser Diagnostics of RF Hydrogen Plasma Reactors: Application to the Processing of III-V Materials", B. L. Preppernau, et al., Ohio State University, WL-TR-93-2046, DTIC AD No. A272659.

AF95-179 TITLE: Cooling of High Speed Rotating Machines

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion

OBJECTIVE: Develop and evaluate cooling components and integrated systems for high speed rotating power related machines.

DESCRIPTION: Proposal should address the development of cooling systems and components for high speed rotating machines and integral power electronics, all of which have been shrinking in size and increasing in power. Future trends will require motors/generators to be located inside of turbine engines where minimal cooling will be available. Generators will also shrink in size and will operate at high speeds where cooling air will cause windage problems. A solution to these harsh environments where minimal or no heat sink is available, is the utilization of a revolutionary thermal control approach. Possible solution approaches could include the utilization of heat pipes, rotating thermosyphons, and fuel or spray cooling.

PHASE I: Phase I will concentrate on problem definition, system benefit studies, and key technology demonstrations.

PHASE II: Phase II will concentrate on development of prototype components, subsystem demonstrations, and hardware development.

COMMERCIAL POTENTIAL: This technology has application for all commercial high speed motors, generators, and engines and these machines are found in almost every form of transportation (commercial air, high speed rail, and automotive), power generation, and manufacturing facilities.

REFERENCES:
"Thermal Modeling of Electrical Machines Cooled by Heat Pipes;" Abdel-Hakim, M. and Abdel-Aziz, M.M.; Modeling, Simulation and Control, v 6,n 2, 1986, p47-55.

"Evaluation of Liquid and Two-Phase Cooling Techniques for Use in Electric Machinery," Wanniarachchi, A.S. and Marto, P.J.; Naval Postgraduate School, Monterey, CA; NTIS No: AD-A149 528/2/XAB.

AF95-180 TITLE: Turbine Technology

CATEGORY: Basic Research
DOD TECHNOLOGIES: Propulsion and Energy Conversion

OBJECTIVE: Improve performance, durability, and reliability of turbine components.

DESCRIPTION: Research and development in turbine component technology which centers on meeting the Integrated High Performance Turbine Engine Technology (IHPTET) goals. Associated studies are conducted in turbine aerodynamics, heat transfer and cooling flow research, computational fluid dynamics (CFD) analyses, instrumentation, turbulent flows, uses of high temperature composite materials, seals and coatings.

PHASE I: Explore the feasibility of a new concept or concepts, through analysis or small scale testing, to demonstrate the potential merits and payoff of the concept.

PHASE II: Provide detailed analytical derivations, prototype and/or hardware demonstration.

COMMERCIAL POTENTIAL: Higher performance turbine engines and associated technologies will lead to more efficient, quieter and environmentally acceptable commercial propulsion and power generating systems. Turbine technology improvements play a major role in military applications and typically transition to commercial use.

REFERENCES:
"High Turbulence Heat Transfer and Cooling in Gas Turbines," R. B. Rivir and W. A. Troha, AGARD 80th Propulsion and Energetics Panel, Antalya, Turkey, October 1992.

"Effect of High Turbulence on Wall Shear and Heat Transfer," Badri Narayanana, R. B. Rivir, and C. D. MacArthur, Fifth Asian Congress of Fluid Mechanics, Darjon, Korea, August 1992.

"Heat Transfer on a Flat Surface Under a Region of Turbulence Separation," R. B. Rivir, J. P. Johnson, and J. K. Eaton, ASME International Gas Turbine and Aero Engine Congress, Cologne, Germany, ASME Paper 92-GT-1, June 1992.

"Heat Transfer on a Flat Surface Under a Region of Turbulence Separation," R. B. Rivir, J. P. Johnson, and J. K. Eaton, ASME International Gas Turbine and Aero Engine Congress, Cologne, Germany, ASME Paper 92-GT-1 to be published in transactions of ASME.

"Film Cooling Effectiveness in High Turbulence Flow," G. W. Jumper, W. C. Elrod, and R. B. Rivir, Journal of Turbomachinery, July 1991.

AF95-181 TITLE: Compression System Design Methodology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop and advance the aerodynamic/mechanical state-of-the-art compression systems and secondary flow systems.

DESCRIPTION: A major trend in compression system hardware is the increased utilization of low aspect ratio blading, solid or hollow blisks, and three-dimensional design methodology. The primary and secondary flow system design capability which is currently two-dimensional must be extended fully into three dimensions to adequately exploit these trends. Areas of prime technical importance include blade/vane sweep, shock/boundary layer interaction, endwall and secondary flows, time unsteadiness, forced response and mistuning in compression systems, and innovative diagnostic instrumentation. Areas of particular interest in secondary flow system design include counter-rotation, trenching, brush seals, and disk pumping in regions as far back in the engine as the turbine shroud area.

PHASE I: Phase I will result in concepts for the development of an advanced compression system or a secondary flow system design.

PHASE II: Phase II will result in bench tested technology concepts or software compatible with Wright Laboratory computer systems for advanced compression system or secondary flow system design, adequately documented to be acceptable to the technical community.

COMMERCIAL POTENTIAL: All commercial gas turbine engines require compression and secondary-flow systems. The improvements gained in compression and secondary flow system performance and efficiency will therefore directly benefit commercial turbine engines, helping the United States engine manufacturers to maintain superiority in the global commercial engine market. Performance and efficiency gains would also translate into monetary savings for commercial airlines by reducing fuel consumption.

REFERENCES:
Bullock, R., and Johnson, L. Aerodynamic Design of Axial-Flow Compressors, "Chapter III - Compressor Design System", NASA SP-36, 1965.

Moore, A., "Gas Turbine Engine Internal Air Systems - A Review of the Requirements and the Problems", ASME Paptеr 75-WA/FT-1, November 1975.

Ferfuson, J.F., "Brushes as High Performance Gas Turbine Seals", ASME 88-GT-182, June 1988.

AF95-182 TITLE: Surface Enhancement Processes and Life Increases for Airfoils

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop technologies that enhance the life and design of turbine engine airfoils.

DESCRIPTION: Turbine engine airfoils must endure a very hazardous operating environment. The life of these airfoils is reduced by, among other factors, foreign object damage, high cycle fatigue and extreme temperatures. The Air Force needs advanced processing techniques which are capable of improving advanced airfoil design and analytical codes which are capable of accurately assessing their benefits. The beneficial effects of current coatings and life enhancement coldworking procedures, such as shotpeening/laser shock processing, are among the processes which must be analytically quantified. Furthermore, life limiting factors such as high-cycle fatigue and oxidation corrosion need continued investigation, and analytical codes need to be developed to access the cumulative damage effects of these design drivers.

PHASE I: The goals of Phase I are to identify a new processing technique capable of improving airfoil design, quantify its payoff, and conduct a small scale experiment to demonstrate concept feasibility. If a computer code is to be written, sufficient documentation of the physics-based source code and an estimate of enhanced capability are required.

PHASE II: A full-scale processing system will be optimized to enhance airfoil life, or computer codes will be developed which are compatible with Wright Laboratory systems to enhance blade life.

COMMERCIAL POTENTIAL: All commercial engine manufacturers are bound by the same airfoil design constraints as the Air Force. Airfoil life is a limiting feature in all gas turbine engines, and improvements would create significant savings in blade life costs and flight safety. The technology developed under this topic would also have application to initiatives such as artificial joints.

REFERENCES:
Malush, Rudolph E., "An Investigation of the Hot Corrosion Protectivity Behavior of Platinum Modified Aluminide Coatings on Nickel-Based Superalloys," Master's Thesis, Naval Postgraduate School, Monterey CA, DTIC Accession No. A181795

AF95-183 TITLE: Thermal Management for Controls and Accessories on Advanced Gas Turbine Engines

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion

OBJECTIVE: Develop a thermal management concept for controls and accessories (C&A) subsystems on advanced jet engines.

DESCRIPTION: Aircraft gas turbines produce not only thrust but also secondary power for engine accessories as well as various airframe utility subsystems. On current engines, initial power extraction is accomplished mechanically, via shafts and gearboxes, and pneumatically, via compressor bleed air extraction. On future engines, the heavy mechanical power generation system will be replaced by a simple starter/generator mounted on the high pressure spool. The same power electronics and electrical machine technologies that make this approach viable will also allow centralized hydraulic systems to be replaced by electric motors at every actuator. Magnetic bearings will replace oil-lubricated bearings for rotor support to facilitate higher rotational speeds and higher cycle temperatures. The advantages of this revolutionary engine configuration include reduced weight, increased performance, and reduced operating costs. However, it creates a significant thermal management challenge. Traditional hydraulic and lubrication systems performed the additional function of transferring waste heat from otherwise remote or inaccessible locations to the fuel system, which then dumps it into the exhaust gas stream and out of the aircraft. Unlike hydraulic systems, electrical power distribution systems have distributed heat loads with no built-in cooling circuit. Advances in high-temperature power electronics and electromagnetic materials will allow uncooled operation of some accessories, but cooling will be a significant issue for buried components like the starter/generator and magnetic bearings. A lightweight thermal management concept is required to realize the full benefits of the propulsion concept described above.

PHASE I: The goal of the Phase I program is to conceptually design a C&A subsystem with no hydraulics or oil. The design should take into account the temperature capabilities of advanced power electronic devices and electrical machines, and develop a thermal management concept that allows their operation in and on an advanced gas turbine engine. The C&A package shall include a starter/generator, magnetic bearings, electrically or pneumatically powered actuators and pumps, ancillary control and power electronics, and any required cooling subsystem(s).

PHASE II: The goal of the Phase II program is to bench demonstrate the thermal management concept developed in Phase I. The bench setup shall be representative of the Phase I C&A concept and provide the expected thermal loads seen by the C&A components. The bench shall be instrumented to provide substantiation of the cooling effectiveness of the Thermal Management System.

COMMERCIAL POTENTIAL: Commercial aircraft engines will realize significant benefits in terms of weight and operating cost reduction by transitioning to electric C&A. Airline maintenance costs will go down. The elimination of hydraulic fluid and oil reduces the exposure of maintenance personnel to hazardous materials.

REFERENCES:
Electromagnetic: Electromechanical Machines, Second Edition, L.W. Matsch, 1977, T.Y. Crowell Company, Inc.

AF95-184 TITLE: Diagnostics Development for Supersonic Combusting Flows

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop nonintrusive diagnostic instrumentation and/or measurement technique for use in supersonic/subsonic combusting flows.

DESCRIPTION: Obtaining accurate measurements of various parameters in a combusting flow field without disturbing the flow is a difficult task. Various optical "flow" diagnostics techniques are currently under development with the intent that it will eventually be used in a test cell environment versus laboratory conditions. The need still exists for the development of new techniques, or refinement of the currently available techniques to allow accurate measurements of the velocity, temperature, density, fuel concentration, and the constituency of the exhaust effluence for hydrocarbon and hydrogen fueled propulsion systems. Both statistical and time-averaged measurements are required to allow validation of the analytical predictions. In order to assess the performance potential of supersonic combustor "engines" or various engine components, new instrumentation and associated measurement techniques are also required. In particular, the development of micro-scale high response (greater than 50 kHz) optical sensors and methods for measurement of wall pressure, temperature, skin friction, and heat transfer rate capable of surviving the severe combustor environments is highly desirable. The instrumentation and associated measurement techniques proposed must be hardened to withstand harsh test cell environments and require only minimal pre- and post-test calibration. It is anticipated that a complete operating system to be utilized in a government supersonic combustion test facility would be a deliverable item at the end of Phase II effort.

PHASE I: The minimum objective of the Phase I program is to develop/refine the measurement technique and/or the instrumentation concept to allow proof-of-concept demonstration in representative supersonic and subsonic research combustors.

PHASE II: The objective of the Phase II program would be to develop the instrumentation and the associated measurement techniques to a point where it could be easily used in realistic combustor temperature and pressure environment under realistic flow conditions.

COMMERCIAL POTENTIAL: Similar if not identical instrumentation and measurement techniques are required in automotive engineering and commercial aerospace industry. Commercial success is, however, dependent on sensor/instrumentation durability, practicality, accuracy, and cost. There is, however, a great market in the U.S. and abroad for commercialization of optical measurement sensors.

REFERENCES:

T. E. Parker, et al., "Optical Diagnostics in Supersonic Combusting Systems," WL-TR-91-2101, AD #253463.

K. M. Chadwick, et al., "Direct Measurement of Skin Friction in Supersonic Combustion Flow Fields," ASME-92-GT-320.

J. M. Hager, et al., "Experimental Performance of a Heat Flux Micro-Sensor," ASME-92-GT-256.

J. A. Schetz, F. S. Billig, "Flow Field Analysis of a Scramjet Combustor with a Coaxial Fuel Jet," AIAA, vol. 20, pp 1268-1274, Sept. 1982.

E. R. Van Driest, "The Problem of Aerodynamic Heating," Aeronautical Engineering Review, Vol 15, pp 26-41.

AF95-185 TITLE: High Mach Combined Cycle Engine Technology

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop key technologies for combined cycle engines operating from Mach 0 to 6 flight speeds.

DESCRIPTION: Investigations of combined cycle propulsion systems have shown turboramjets (TurboRJs), air-turborockets (ATR), and pulsed detonation engines (PDE) to be attractive propulsion concepts at Mach 0 to 6 flight speeds. TurboRJ and ATRs combine the flexibility and efficiency of turbomachinery at flight speeds of Mach 0 to 4 with the simplicity, low weight, and high specific impulse of the ramjet in the Mach 3 to 6 flight range. PDEs combine the simplicity and efficiency of the detonation wave combustion with the capability of airbreathing at flight speeds of Mach 0 to 4 and rocket operation in the Mach 4+ flight range. Currently, plans are underway to develop technologies for the TurboRJ, ATR, and PDE. Examples of technologies which are of interest include air intake systems, exit nozzles, solutions to reduce total pressure loss, innovative ignition methods, solutions to reduce the length and weight of inlet, nozzle and combustor components, ramburner structures, ramburner fuel injection/flameholding schemes, endothermic fuel reactor/engine integration, heat exchangers, ramburner cooling techniques, and air driven power generation devices. Proof-of-concept testing is preferred, but analytical investigations will also be considered.

PHASE I: The goals of Phase I will be to identify a novel concept, quantify its payoff, and conduct a small-scale experiment to demonstrate concept feasibility. If a strictly analytical approach is proposed, sufficient analysis must be performed to demonstrate some degree of concept feasibility and plan experiments for Phase II.

PHASE II: Larger scale development would be undertaken in Phase II. The proposal should include plans for Phase II testing, which would include identification of appropriate facilities. The goals of Phase III would be to integrate the components developed in Phase II into a combined cycle engine demonstrator and evaluate its performance.

COMMERCIAL POTENTIAL: Combined Cycle Engines have application to a multitude of vehicles which require efficient acceleration and cruise capabilities. Military application might include long-range, high speed aircraft for reconnaissance and strike missions, stand-off missiles, and drones. Commercial application might include high-speed civil transport or passenger aircraft. Dual use applications include military/commercial space launch vehicles which require an airbreathing propulsion system for the initial atmospheric boost phase. Both the Pegasus launch vehicle and the National Aerospace Plane could benefit from the use of airbreathing boost propulsion.

REFERENCES:
AIAA-90-2337, Hydrocarbon-Fueled Scramjet Combustor Investigation, I. W. Kay, W. T. Peschke and R. N. Guile, 16-18 July 1990.

AIAA 93-1832, Further Exploration of an Airbreathing Pegasus Alternative, N. R. Roble, D. P. Petters and K. J. Fisherkeller, 28-30 June 1993.

AF95-186 TITLE: Environmentally Benign Aviation Fuels and Lubricants

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Minimize hazardous waste in life cycle of aviation fuels and lubricants.

DESCRIPTION: In producing, utilizing, consuming, and disposing of aviation fuels and lubricants, there is a continual interaction with the environment. The materials are products of petroleum refining or synthetically produced. They are often stored for long periods of time. Lubes are used for extended periods of time and fuels produce gaseous pollutants when burned or liquid pollutants when thermally/oxidatively stressed. This topic seeks technology that can reduce the risk of inadvertent environmental damage during the life cycle of aviation fuels and lubricants or can reduce the amount of pollutants discharged during routine use of these materials. Some examples of technologies that fall within this description are:

- Alternative additives that are environmentally benign
- Specification tests methods that do not use Volatile Organic Compounds (VOCs) and Ozone Depleting Compounds (ODCs)
- Detection of adulterated fuels and lubricants
- Combustion and incineration strategies that minimize pollution formation in the effluent
- Separation techniques for isolating hazardous chemicals from otherwise nonhazardous fuel or oil waste
- Environmentally benign techniques for recycling or disposing of spent lubricants

PHASE I: The goals of this phase are to identify technology that could make the life cycle of aviation fuels or lubricants more environmentally benign and assess the impact on Air Force operations of implementing the technology.

PHASE II: The objectives of this phase are to demonstrate and document the environmental advantage of the proposed technology, the extent to which weapon system performance and cost would be impacted, and the implementation path for the new technology.

COMMERCIAL POTENTIAL: Environmental control technology for military aviation fuels and lubricants would be directly applicable to the commercial sector. There is a large overlap between military and commercial aviation fuels and lubricants. Therefore, technology that minimizes negative environmental impact from the production, use, and disposition of such materials is directly applicable to both user communities.

REFERENCES:
Centers, P. W., Potential neurotoxin formation in thermally degraded synthetic ester turbine lubricants, ARch. Toxicol., 66, 679-680 (1992).

Micallef, R. A. and A. Squires, Characterization of Used MIL-L-7808 Lubricants, Air Force Technical Report AFWAL-TR-85-2017 (AD No. 158624), Aero Propulsion Laboratory.

Waste Oil Reclamation (Feb 70--Present), National Technical Information Services. Order number PB94-854312, Dept. of Commerce, Washington D.C., 5285 Port Royal Road, Springfield, VA 22161.

Barnard J. A., Bradley, J.N., Flame and Combustion, 2nd Edition, New York, NY, Chapman and Hall, 1985, pg 266-276.
Finlayson-Pitts, B.J., Pitts, J.N., Atmospheric Chemistry, New York, NY,
Wiley and Sons, 1986.

AF95-187 TITLE: Thermal Interactions in Rolling Bearing Dynamics

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop thermal interaction models for implementation in available bearing dynamics computer codes.

DESCRIPTION: Over the past two decades, significant efforts have been made towards modeling the dynamics performance of rolling element bearings. Computer codes are now available to perform real-time dynamics analysis of all types of rolling bearings under fairly complex operating environments. However, most of the current work is restricted to isothermal conditions and there is little or no consideration for thermal interactions in the bearings. The objectives of this effort are, therefore, to develop models for thermal interactions, implement the models in available bearing dynamics computer codes, and demonstrate the significance of thermal interactions in overall dynamic behavior of rolling element bearings. The computational procedures shall be incorporated in the bearing dynamics codes and the practical significance of the model and feasibility of the overall approach shall be demonstrated by dynamic analysis for each type of bearing under typical turbine engine operating environment. Heat transfer to circulating liquid lubricants and models for convective cooling systems, such as forced air in solid lubricated bearings, shall be included in the complete models. Also, the significance of thermal transients shall be established and any thermally induced instabilities in the rolling element motion shall be modeled for all types of rolling bearings.

PHASE I: The goals of Phase I will be development of analytical models and associated computer codes for the computation of rolling element-to-race contact temperatures. These models will include ball, cylindrical, and tapered roller bearings. Models for both liquid and solid lubrication will be developed. The models will then be tested under typical turbine engine operating conditions.

PHASE II: The goals of Phase II will be to develop a complete heat transfer model between the bearing elements as well as the system environment. The complete model should be able to handle convection cooling from forced air in solid lubricated bearings and heat transfer to circulating liquid lubricants.

COMMERCIAL POTENTIAL: Numerous companies doing bearing research and design use bearing dynamics codes to design bearings. However, these codes are limited in their thermal analysis capabilities. A design tool that includes a complete thermal analysis will greatly enhance the bearing designer's ability to precisely specify bearing design parameters to meet requirements. It is anticipated that a tool of this sort would have a substantial commercial market for applications such as industrial gas turbines, rocket propulsion turbo pumps, and aerospace guidance equipment.

REFERENCES:
"Animated Computer Graphics Modeling of Rolling Bearing Dynamics," Pradeep K. Gupta, technical report WL-TR-91-2129, DTIC Accession #A244 375.

AF95-188 TITLE: Ultrafast Laser Diagnostics for Absolute Number Density Measurements in Combustion

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Demonstrate advanced, laser-based concepts for the quantitation of key combustion species.

DESCRIPTION: A principal driving force in the continuing development of advanced gas turbine combustors is the reduction of environmentally hazardous emissions. Emerging gas turbine design methodologies increasingly seek to achieve this low-emissions goal through the use of computational fluid dynamics and chemistry (CFDC) codes. The successful performance of these codes is predicated upon their experimental validation, and absolute number density measurements for key combustion species are required to effect validation. This topic seeks advanced, nonintrusive, laser-based diagnostics capable of quantitating these combustion species. Techniques which provide multidimensional images and/or time-resolved point measurements in a

combusting flowfield will be particularly advantageous for model validation. Rapid, repetitive quantitation in turbulent flowfields will provide key statistics required to refine and improve CFDC turbulence models.

PHASE I: Efforts in this phase should demonstrate experimentally on a laboratory scale the potential of an advanced diagnostic concept to provide improved quantitation of key combustion species as compared to existing state-of-the-art methodologies. Modeling and other computational support of the concept is advantageous but not sufficient for a Phase I effort.

PHASE II: Efforts in this phase should provide complete demonstration and documentation of the performance gains associated with the advanced diagnostic concept. Ideally, this demonstration would be achieved in conjunction with a combustion application of interest to the Air Force.

COMMERCIAL POTENTIAL: The gas turbine design methodologies validated through the use of these advanced, laser-based diagnostics will have tremendous impact on the future of both military and commercial aviation, particularly as these techniques contribute to the reduction of emissions. The laser techniques themselves have great dual use commercialization potential as well. Currently, ultrafast laser techniques impact a broad spectrum of sciences and technologies including chemistry, physics, biochemistry, microelectronics, and telecommunications. Recent applications include the study of chemical reaction dynamics, the measurement of enzyme activity, the characterization of advanced semiconductor materials, and the development of high-bandwidth fiber-optic communication systems.

REFERENCES:
G. B. King, N. M. Laurendeau, and F. E. Lytle, "Asynchronous Optical Sampling for Laser-Based Combustion Diagnostics in High Pressure Flames," AFOSR-TR-92-0391, (Air Force Office of Scientific Research, Bolling AFB DC, 23 Apr 1992). DTIC accession number AD-A250 206.

AF95-189 TITLE: Integrated In-Line Wear and Lubricant Condition Sensor

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop an integrated in-line sensor for monitoring wear and lubricant thermal-oxidative condition in turbine engines.

DESCRIPTION: In-line monitoring of wear and lubricant thermal oxidative condition could have significant positive impact on operational readiness and turbine engine maintenance costs. As turbine fleets age and as advanced, higher temperature turbine engines enter the market, the mechanical and thermal oxidative stresses placed on the oil system will increase significantly, thereby establishing conditions that will more quickly and harshly wear mechanical systems and degrade the lubricant. Excessive wear and lubricant degradation can lead to severe engine component damage or failure. Furthermore, it is beneficial to know exactly when to change the oil. Premature oil changes impact the environment and produce excessive and unnecessary cost for both labor and materials as well as decreased operational readiness. However, oil changes that are too late can result in even greater costs due to the need for increased engine maintenance caused by excessively degraded oil. To avoid these potential problems, development of small, lightweight (less than 1 or 2 pounds), and inexpensive sensors that integrate wear and lubricant condition monitoring capabilities is desirable. This could replace expensive and time intensive laboratory analysis and alert personnel to operational wear and oil degradation problems in real time. Also, it could allow "just-in-time" oil change intervals to be established. A sensor of this type should accurately and repeatably track engine wear and thermal oxidative condition of the lubricant. The sensor should be capable of being easily retrofitted into existing turbine engines or incorporated into future engine designs.

PHASE I: A successful Phase I effort would result in development and proof-of-concept testing of a lab model or benchtop sensor. The testing should be accomplished on a wide variety of turbine lubricant samples representing low to high wear concentrations and thermal oxidative degradation levels, to prove monitoring capability under realistic operational turbine engine conditions. A sensor design should be generated that would meet all aforementioned requirements.

PHASE II: Phase II work should include prototype development from the Phase I design of a working integrated sensor and networking with turbine engine users and manufacturers to arrange for engine testing of the developed prototype.

COMMERCIAL POTENTIAL: A successfully developed integrated in-line wear and lubricant condition sensor would have excellent commercialization potential for application in airline, military, and industrial turbines.

REFERENCES:
Centers, P. W. and Price, F. D., "Real-Time Simultaneous In-Line Wear and Lubricant Condition Monitoring," Technical Report, AFWAL-TR-87-2015, June 1987, DTIC accession number: ADA183286.

AF95-190 TITLE: Thermally Stable Aviation Turbine Fuels, Fuel Systems, and Test Methods

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion
OBJECTIVE: Develop thermally stable aviation fuels and new test methods with which to analyze and evaluate them.

DESCRIPTION: Subsystem temperatures and heat loads are increasing on new and future aircraft that utilize the fuel as a heat sink or coolant. Subjecting the fuel to higher temperatures for longer periods of time causes degradation and fouling of fuel system components, most notably, fuel injectors, valves, and augmenter spraybars/sprayrings. This topic seeks development of technologies that reduce aircraft operational costs and fuel system maintenance caused by fouling due to high temperature fuel stressing. Also of interest is the development of new reliable test methods, equipment, and models to evaluate fuel properties, examine fuel chemistry, and predict fuel system problems. Some examples of technologies that fall within this description are: fuel additives or fuel system design approaches that prevent component fouling under high temperature aircraft fuel system conditions; reliable, inexpensive analytical test methods or instrumentation (suitable either for fundamental fuels research or for quality control/field use) that define and determine thermal stability or identify and quantify fuel degradation products; and small, lightweight, rugged techniques/instrumentation suitable for use as onboard fuel system monitoring devices.

PHASE I: The goal of Phase I is to demonstrate feasibility and payoff of the proposed technology.

PHASE II: The objective of Phase II is to complete validation of a prototype system.

COMMERCIAL POTENTIAL: All technologies developed under this topic would have wide application to the commercial aviation fuel market.

REFERENCES:
"CRC Literature Survey on the Thermal Oxidation Stability of Jet Fuel," CRC Report No. 509, April 1979, Coordinating Research Council, Inc., 219 Perimeter Center Parkway, Atlanta GA 30346.

AF95-191 TITLE: Manufacturing Process Analysis of Advanced Aircraft Gas Turbine Engines

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion and Energy Conversion

OBJECTIVE: Conduct an analysis of the manufacturing processes for an advanced, high performance gas turbine engine.

DESCRIPTION: Future, high performance gas turbine engines will be characterized by the use of advanced, lightweight, high strength materials, such as organic matrix composites and metal matrix composites in both static and rotating structures. Currently, these new materials are in the early stages of development and are just beginning to appear in some components of advanced technology demonstrator engines. At this point in time, fabricating engine quality components with these new materials is extremely labor intensive with very low yield rates. The manufacturing processes required to achieve low cost, high quality engine parts are currently not optimized and, in some cases, undefined. At the heart of achieving affordable, high performance gas turbine engines is the ability to produce advanced technology components in a cost effective manner. This research effort shall conduct a thorough analysis of current state-of-the-art manufacturing processes for future high performance gas turbine engines and offer recommendations for reducing manufacturing costs through innovative manufacturing methods or through optimized manufacturing methods.

PHASE I: The goal of the Phase I program is to establish the manufacturing baseline for future, high performance gas turbine engines and to conduct a thorough analysis of the manufacturing process for these advanced engines, including the manufacturing cost for each major engine component and a layout of the manufacturing facility and shop floor.

PHASE II: The goal of the Phase II program is to demonstrate, through the fabrication of an engine component, advanced manufacturing methods that are significantly more cost effective than today's current practices for the same advanced material.

COMMERCIAL POTENTIAL: Commercial aircraft engine manufacturers will realize significant benefits in terms of higher performance and reduced manufacturing cost by utilizing the advanced materials and manufacturing methods addressed in this research effort. This research has far reaching potential for dual use capability.

REFERENCES:
Defense Manufacturing Conference '93, Proceedings of Technical Presentations, Volumes I and II, "Integrating the Manufacturing Base," 29 Nov-2 Dec 1993, San Francisco, CA.

AF95-192 TITLE: Aero Propulsion and Power

CATEGORY: Basic Research
DOD TECHNOLOGIES: Propulsion and Energy Conversion

OBJECTIVE: Design, build and test auxiliary power units with improved performance and maintainability.

DESCRIPTION: The Aero Propulsion and Power Directorate pursues major thrusts at high power levels in integrated propulsion and electrical power technologies. The research and development has resulted in significant advances in compressors, gas generators, materials and high temperature electriclal power conditioning. The new integrated propulsion/electrical systems derived under Integrated High Performance Turbine Engine Technology (IHPTET) have resulted in lower weights, and greater fuel efficiencies. The SBIR requirements are to assess and analyze the transfer of these technology advances to AF and DoD ground power users and to civilian applications such as in emergency power needs and disaster relief to remote areas. The applications are estimated to be in the range of 100's kw to several MW instead of the very high power levels (or equivalent thrust) of AF flight applications. Modularity in the proposed power systems should be preserved so that scaling of power outputs shall not require totally new components. Direct transfer of all IHPTET advances is not anticipated. Necessary features should be portability, ease of use and serviceability considering use in remote areas.

PHASE I: Explore the feasibility of a new concept or concepts, through analysis or small scale testing to demonstrate the potential merits of the concept.

PHASE II: Provide detailed analytical derivations and prototypical device or hardware demonstrations.

COMMERCIAL POTENTIAL: The higher performance turbine engines and associated technologies will lead to more efficient, quieter and environmentally acceptable commercial propulsion and power generating systems. The modular engine concepts and new fuels and lubricants developed under this program are suitable for integration into new engines for commercial use or as retrofits and provide low cost, easily maintained systems. The power developments transition naturally into emergency power sources for large installations, disaster preparedness and efficient utilization of natural gas that is presently flared.

AF95-193 TITLE: Composite Manufacturing Process Control

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop a process control system for controlling and improving part quality during lay-up

DESCRIPTION: Process controls are one of the key elements of building quality into an organic matrix advanced composite structure. Built in quality reduces inspection, rework and scrap costs, increases reliability and results in lower overall acquisition costs. The majority of process controls investigated to date have focused on the curing process. However, process controls are needed on all of the manufacturing operations involved in the production of a composite part. Many composite structures, because of their complexity, continue to be manufactured by the hand lay-up process. Additional fabrication techniques also being used for ply lay-up include automated tape machines and tow placement machines. It is critical in the manufacture of a composite part that the plies be laid up in the proper sequence, proper location, and proper orientation, regardless of the manufacturing process.

PHASE I: Demonstrate the feasibility of a system which handles and controls quality information relative to the ply lay-up operations. A demonstration system will be configured to receive the desired data in a suitable form. The concept will be demonstrated by the fabrication of a composite laminate.

PHASE II: Build upon Phase I work to refine the concepts and ready to concept for factory floor operations.

COMMERCIAL POTENTIAL: Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical to sporting goods.

REFERENCES:
Contract No.F33615-74-C-5072, "Low Cost Foreign Object Damage (FOD) Resistant Organic Matrix Fan Blades", AFWAL-TR-81-4084, Feb. 1982, General Electric, ADB069242L.

AF95-194 TITLE: Low Cost Advanced Composite Structures

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop room temperature curing resin formulation for low cost, aerospace quality advanced composite structures.

DESCRIPTION: Decreasing defense budgets along with increasing commercial requirements necessitates the development of low cost organic matrix composites. Affordability includes all steps of the manufacturing process from starting materials to final inspection. New or modified materials must be able to produce aerospace quality components and minimal cost independent production quantity. The process starts with the resin matrix. Subsequent manufacturing operations, including tooling and autoclave requirements, are dictated by the resin chemistry. Eliminating the need to process in autoclave environments will have a direct impact on cost reduction. The need exists for the development of resin chemistry which will be amenable to room temperature curing graphite reinforced composite structures but which subsequently possess the same characteristics as today's state-of-the-are 3500 epoxy systems.

PHASE I: Demonstrate the feasibility of a room temperature curing resin system which has similar handling and performance properties as a state-of-the-are aerospace grade epoxy resin system. The concept will be demonstrated by the fabrication of a composite laminate.

PHASE II: Build upon Phase I work to refine and scale-up the resin system from laboratory scale to larger quantities. Identify any requirements and/or concerns necessary for scale-up to pilot plant level.

COMMERCIAL POTENTIAL: Composite materials have already found widespread application in the commercial market. Improved quality and lower part cost are desired features whether the market is military or commercial. The concept developed herein will be applicable and beneficial to industries ranging from aerospace to automotive to medical to sporting goods.

REFERENCES:
Contract No.F33615-92-C-5971, "Low Cost Composite Processing", McDonnell Douglas Aerospace, Semiannual Reports, April 1993, and Oct. 1993.

AF95-195 TITLE: Quality Control Techniques for Semiconductor Wafer Surface Processing

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Establish rapid methods to quantitatively and nondestructively measure the microroughness/surface quality of semiconductor surfaces.

DESCRIPTION: Establish and demonstrate a capability to quantitatively measure the roughness of semiconductor surface, and of the surfaces of deposits utilized in the processing of microelectronics on a microscale. Obtain information on the roughness scale in angstrom range and rapidly cover the entire wafer surface. The instrumentation shall be amenable to production environment. Separate proposals will be submitted for each type/class of wafer material selected.

PHASE I: Select an approach and demonstrate the feasibility of the approach to measure the microroughness of semiconductor surfaces, and surface layer crystal surfaces, it is desirable to have the ability to assess the surface damage. The measurement must be rapid and nondestructive and amenable to a production environment. The capability of the initial design will be demonstrated using test structures to define specific range of the instruments capability for monitoring key machine and process variables that can be implemented in SPC programs.

PHASE II: Demonstrate the applicability of the measurement approach to process control in semiconductor processing. For instance, show that the method can detect roughening relates to cleaning variables. Also, demonstrate that the measured values can be verified as an independent method. Demonstrate that the technique can be used to measure roughening and damage introduced by plasma patterning. Provide a design concept for an instrument that can carry out the measurement automatically in production and scan the entire wafer surface. Software for both data acquisition and processing will be established.

COMMERCIAL POTENTIAL: Significant cost reduction and wafer quality improvements beyond present day capability for both military and commercial can be realized. These techniques will be capable of sorting out wafers for the semiconductor manufacturing producibility as well as quality monitoring steps.

REFERENCES:
"Scanning Tunneling Microscopy in Research and Development", V. Elings and J. Gurley, Research and Development, Feb.89

AF95-196 TITLE: Internal Real-Time Distributed Object Management System

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop and demonstrate a completely internal memory stored and executed real-time distributed object management transaction system.

DESCRIPTION: This research is to identify and analyze requirements, plan, develop a prototype, and demonstrate and internal memory object control and administration system. The Internal Real-Time Distributed Object Management System (IR-DOMS) system will be required to be capable of managing and assuring in real-time all transactions, activities, procedures, computer programs, networks, data and relationships in the distributed heterogeneous IR-DOMS technology can be tailored for initial demonstrations supporting manufacturing applications environments. Industry and government system administrators have the IR-DOMS requirements for viewing, optimizing, control and administration of distributed object manufacturing application program production mixes. The system administrators require use of selectable user friendly graphical interface. IR-DOMS technology will be demonstrated as services internal to the Object Management System controlling the state of the entire distributed heterogeneous architecture as implemented.

PHASE I: 1) Provide the project technical plan of action, schedule and funding profile; 2) Identify requirements and develop required technical extensions to support a logical IR- DOMS system prototype; 3) Develop the software and assemble the equipment for the IR-DOMS prototype; 4) Develop the process scenario to exercise and measure the performance of IR-DOMS; 5) Integrate and test the IR-DOMS prototype and consider corporate sponsorship participation during the IR-DOMS development process; and 6) Demonstrate the IR-DOMS prototype to a (contractor selected) Industry Review Board and consider its use during the course of the project.

PHASE II: 1) Provide the project technical plan of action, schedule and funding profile; 2) Obtain corporate sponsors and re-establish the (contractor selected) Industry Review Board and consider its use during the course of the project; 3) Develop a production Internal Real-Time Distributed Object Management System; 4) Demonstrate the IR-DOMS by producing three different products for each corporate sponsor solving different application problems specified by the sponsors for dual use, solutions to industry and government information sharing; 5) Prepare a market analysis and report for IR-DOMS in three market sector; and 6) Demonstrate the IR-DOMS scenarios publicly.

COMMERCIAL POTENTIAL: Dual use is an integral part of this project. The IR-DOMS technology can be used by any manufacturer to support the production of products for virtually any market space such as the process industries, automobile, petroleum, medical, aerospace, home and business appliances, electronics, and utilities.

REFERENCES: # AD-A098353

AF95-197 TITLE: Product Data Netshape Forming Machine

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Industrial Production

OBJECTIVE: Develop a product data driven automatic netshape forming machine that will produce durable discrete parts.

DESCRIPTION: This research is to identify and analyze requirements, plan, develop a prototype and demonstrate a machine that will directly use the digital technical product definition data (per ISO-STEP) of the product, to dynamically create the exact shape of the cavity, die set, platen or mold and automatically drive the required features of processes to manufacture the finished part to the specification from the design team product data model. PD-NAFM requirements will support techniques to control material properties, their characteristics, and act on state changes in material viscosity, temperature and molecular structure; enabling the highest possible quality product and optimizing life cycle performance. The control parameters must be available for calculation, analysis, and execution as part of the product definition data supporting the total product. The prototype demonstrations will include PD-NAFM performing two of the following while the requirements analysis will include all five as a minimum 1) sheet metal parts (various gauges, different tempers including "W" and having compound complex geometric features); 2) composite parts (including embedding an electronic subassembly and a metal component creating composite hybrids during product manufacture); 3) injection molded parts (plastic and rubber); 4a) create a casting mod (two halves to be joined in PD-NAFM); 4b) then produce the product using the casting just created and PD-NAFM as the process controller; and 5) create forgings. The PD-NAFM processes and products are to be tested, analyzed and reported for quality, cost and specification. Except for hybrid product (whose digital product definition will be imported) production of the PD-NAFM shall transform raw materials via the Product Definition Data directly into a finished durable product.

PHASE I: 1) Provide a project technical plan of action, schedule and funding profile; 2) Develop required technical extensions to the software tools based in the STEP/PDES standard to support the logical system of PD-NAFM prototype; 3) Assemble the manufacturing equipment for the PD-NAFM prototype; 4) Develop the processing system to support the two selected demonstrations by producing the required implements, i.e., die set, clamping system, die blankets, sensors and controls, etc.; 5) Construct and test the PD-NAFM prototype and consider corporate sponsorships participation during the PD-NAFM development process; and 6) Demonstrate the PD-NAFM to a (contractor selected) Industry Review Board.

PHASE II: 1) Provide the project technical plan of action, schedule and funding profile; 2) Obtain corporate sponsors and re-establish the (contractor selected) Industry Review Board and consider its use during the course of the project; 3) Develop a production PD-NAFM that can sustain production with an acceptable mean time between failure rate; 4) Demonstrate the PD-NAFM that meets the requirements produced and prioritized in Phase I. Produce using PD-NAFM three different products for different corporate sponsors dual use product of their specification using different materials (such as aluminum (three different tempers), stainless steel, copper, and composites (multiple plys requiring pressure and temperature to sustain shape, cure materials, etc.) and liquid plastic injection material); 5) Prepare a PD-NAFM market analysis and report in three market sectors; and 6) Demonstrate the PD-NAFM publicly.

COMMERCIAL POTENTIAL: Dual use is an integral part of this project. The technology can be used by any manufacturer to produce products for use in virtually any market space where the manufactured products are piece parts or end item entities made of flat materials or injection molded. The products produced by PD-NAFM will be used by industries such as automobile, petroleum, medical, aerospace, home and business appliances, electronics and utilities.

REFERENCES: # AD-A098353

AF95-198 TITLE: <u>Integrated Tools for Technology Assessment and Development Planning</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop network based software architecture and toolset for matching available technologies to identified deficiencies.

DESCRIPTION: DoD Directives 5000.1 and 5000.2 define the DoD-wide acquisition process. As part of this process, mission area analysis and mission need analysis are performed to identify current operational deficiencies and/or new opportunities. New technologies are then examined relative to these needs, to assess their potential utility. These technologies must be demonstrably better than current methods or other proposed solutions for performing the given mission considering their impact on mission effectiveness, life cycle costs, risks, and availability.Current techniques for identifying and quantifying the impact of a new technology are primarily ad hoc and qualitative. Further, the efforts required to quantify effectiveness, cost and risk in a realistic threat environment require contributions from many technical disciplines, a shared, yet protected data environment, unique software tools, and an integrated team of personnel with disparate backgrounds. A software environment is needed which provides transparent network based data access, tool access and team communications which is tailored to the requirements of the integrated product team. Emphasis must be placed on team and individual data protection, configuration control and automatic archiving for audit trail, while providing improved efficiency and team communications.

PHASE I: Design and demonstrate feasibility of the network based tool framework.

PHASE II: Develop the framework and specific tools.

COMMERCIAL POTENTIAL: Industry is currently challenged to develop new products and integrate maturing technologies including those developed by DoD research facilities. This software toolset, with appropriate tailoring, would be a means for transitioning dual use technologies to many types of commercial systems including automobiles, aircraft, and industrial equipment.

REFERENCES:
1. Pathways to Tomorrow: The Development Planning Process, TR-94-5024 WL/STINFO Office, Wright-Patterson AFB,

AF95-199 TITLE: <u>Methodology for Assessing and Selecting Life Extension Options for Aging Aircraft</u>

CATEGORY: Basic Research
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop model which weighs life extension options and selects the most cost effective.

DESCRIPTION: A phenomenon of the jet age is that aircraft tend to remain in service longer. Budget constraints are forcing worldwide Air Forces to evaluate modifying new and used commercial aircraft for military use and to extend the life of existing military systems. The Committee on Science, Space, and Technology reported that in 1986, nearly half of the U.S. airline fleet was 15 years old. The life expectancy of an aircraft is primarily dependent on the integrity of the electronic systems, structural components, and the materials of which they are made. In addition, most transport type aircraft, both military and civilian, which are over 20 years old have shown structural problems. These problems can all be overcome by replacements, modifications, increased inspections, or a combination of the three, all of which require extensive planning.This is especially true given the many conflicting and often competing options available for extending aircraft life. The model will be applied to mission area assessments, mission need analysis, and cost operational effectiveness analysis. It will address the aging aircraft problems of structural deterioration, subsystem obsolescence, and operational changes. It will rank the competing fixes according to stated needs and overall utility to the system. The end result will be the identification of and rationale for the most cost effective life extension option.

PHASE I: Provide the conceptual design for model methodology. Demonstrate the methodology design concept and its potential in assessing and selecting the best option to address the aging aircraft problem and its impact on service life.

PHASE II: Build a working prototype of the model. This prototype will demonstrate the ability to select the most cost effective option for the selected fleet.

COMMERCIAL POTENTIAL: Commercial aviation organizations will be able to use this model to assess an investment associated with aging aircraft life extension options vs. purchase of new aircraft. Other DoD and Allied Air Forces can apply this methodology to their aircraft inventories.

REFERENCES:

1. "Naval Aircraft and Aging Issues", Agarwala, Vinod S., Naval Air Warfare Center Aircraft Division, Warminister PA, in Proceedings of the International Workshop on Inspection and Evaluation of Aging Aircraft, May 8-21, 1992. DTIC # D335307.

2. Moore, Thomas K., Major, USAF, "Corrosion and Fatigue: Problems in Life Cycle Costing", Moore, Thomas K. Maj USAF, in Defense Management Journal, January 1976 pp 40-53, in Wright Laboratory Technical Library.

3. Opalski, Capt, Frank A. de la Motte, Eddy, from the briefing "Multiple Site Damage (MSD) and Corrosion; Where We Are and Where We Should Go", Opalski, Capt, Frank A., de la Motte, Eddy, briefing at USAF ASIP Conference February 1994.

4. "Proceedings of the International Workshop on Inspection and Evaluation of Aging Aircraft". DTIC # D335289.

AF95-200 TITLE: Automated Methodology for Balancing Avionics Requirements and LCC

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop an integrated methodology for trading avionics suite performance requirements and life cycle costs.

DESCRIPTION: Currently separate methodologies are used to determine avionics mission requirements, suite performance, conceptual/preliminary designs, and cost estimates. In some cases the assessments are done independently by different teams at different locations. This situation results in misinterpretation and a lack of understanding of the interrelationships between performance requirements and life cycle costs, for example, as well as the effects key performance parameters have on other performance parameters, design complexity, and LCC. To properly synthesize cost-effective and supportable avionics suites for a given class of vehicles (e.g., airlifters, tankers, joint or multirole aircraft), a multilevel, automated approach is needed to perform a trade analysis on these performance-cost drivers. The desired methodology will be capable of balancing avionics suite requirements while meeting mission needs and resulting in affordable, risk-acceptable designs.

PHASE I: The methodology will be designed and demonstrated. Key factors and trade-offs required to ensure balanced requirements and affordable designs will be defined. The approach will consider performance, life cycle costs, technology insertion, risks, commonality/standardization, crew workload and supportability as a minimum. The demonstration will involve either a new aircraft system or the avionics modernization of a class of existing systems. The other Phase I output will be a Software Design document for implementation of the model on a state-of-the-art PC.

PHASE II: The model will be developed, documented, demonstrated, and delivered.

COMMERCIAL POTENTIAL: The product has applications to current and future aircraft modernization programs for both DoD and commercial aeronautical systems. Additionally, ground vehicles such as automobile and truck electronics and displays could use this methodology to perform requirements and life cycle cost trades. Commercial markets are worldwide and very large.

Note: We are interested in the proposed model methodology for trading avionics performance requirements vs. LCC. After contract award, data sources will be provided to support contractor cost research.

AF95-201 TITLE: Situational Awareness

CATEGORY: Basic Research
DOD TECHNOLOGIES: Software

OBJECTIVE: Design and implement a Situational Awareness (SA) system model to quantify SA effects.

DESCRIPTION: A flexible SA system concept capability is needed to quantify the character of the total system impacts on the Beyond Visual Range (BVR) to Within Visual Range (WVR) merge. Modifications are needed to current simulations (piloted and/or batch) that model present and future SA systems (sensors, C3I, etc.) that control military and/or commercial FAA operations. The Man-in-the-Loop Air-to-Air System Performance Evaluation Model Version 2 (MIL-AASPEM or MIL2), a key Air Force mission analysis tool, is the suggested candidate model for modification to improve the situational awareness modeling. The MIL2 modification could support the relative effectiveness analysis of subsystem contributions to military and/or commercial system effectiveness. These subsystem contributions are often driven by the nature of the BVR/WVR merger.

PHASE I: Define the SA variables which determine whether a pilot is cognizant of a player or event. Define the modeling techniques to capture SA levels in the region between BVR and WVR. Define probable applications of these SA techniques to other problems (i.e. hazardous waste removal in hostile environments, space applications, etc.).

PHASE II: Incorporate test and demonstrate SA technologies in various scenarios in the simulation environment. The deliverable under this phase is a modified simulation system.

COMMERCIAL POTENTIAL: A possible modeling technique to capture these SA effects is a piloted simulation using virtual technology display devices. By improving the SA environment through this proposed effort, the SA provided by enhanced virtual technology display devices could be applied to areas such as remote hazardous waste removal, virtual manufacturing simulations, training systems, and space applications. This effort provide direct commercial application opportunities for SA modeling techniques.

REFERENCES:
1. Virtual Reality for Air Combat (Final Report) Steven M. Mosher TR-93-002, Feb 93. Available from ASC/XRESM, Tel 513-255-5880, POC Mr. Doug Hodson.

2. Innovative Display Concepts for Field-of-View Expansion in Air Combat Simulation, WL-TR-92-3091. Available from WL/FIGD, POC Mr. Dan Goddard, Tel 513-255-6759.

AF95-202 TITLE: Model Integration through Intelligent Data Parsing and Management

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Provide software tools and processes for performing data transformation and integration between legacy software tools without modifying source code.

DESCRIPTION: The Air Force has a large number of software tools and models, representing a huge investment in development and training costs. These tools are the legacy of historical efforts, and are large, monolithic models, usually coded in FORTRAN. Each has strengths and weaknesses, yet overlap in functionality. It is common for an analyst to run multiple models which require different elements of the same basic input data set. As each model is run, the analyst picks out specific bits and pieces of the output, then retypes these data elements in a different format as input to another model. The result is analysts often spend more time identifying, extracting and transforming data to feed the models rather than in performing analysis of results. It is not feasible to recode these legacy tools, and often times, impractical or infeasible to modify the source code to modify output formats. Yet input and output formats are well documented and understood. Innovative techniques for generically extracting user specified data elements from the output of such tools, performing rudimentary transformations on these elements (like engineering unit conversions), integrating these with data elements from other sources, and preparing input data sets for other models are required. These techniques will be integrated in a tool which enables the analyst to specify the legacy models and data sets and which would automatically create the input data sets and invoke each model as its input data requirements are satisfied.

PHASE I: Define standards/techniques for characterizing input and output data sets across different host computers. Design the interconnection tool. Identify a core set of AF tools to be integrated with the concept during Phase II. Demonstrate the technical feasibility of the concept by a manual application of the concepts.

PHASE II: Develop the tool and techniques, demonstrate the automated concept on the tools identified in Phase I.

COMMERCIAL POTENTIAL: Products of this program have applications throughout the DOD, government, and industry. Organizations which use multiple, commercial off-the-shelf software packages and/or custom developed software and which must share data from a common source have a need for the software tools developed in this effort. Examples include legal, banking and financial, design groups, etc.

AF95-203 TITLE: Improved Recess Drive System for Fasteners

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials

OBJECTIVE: Development of improved recess drive system

DESCRIPTION: The recess drive systems currently used in aerospace applications are inadequate when used with 100 degree countersunk, flush fitting heads. The drive designs are not capable of sustaining the removal torque required to remove the fastener from the aircraft structure without the fastener drive recess sustaining sufficient damage to render it useless. Also, after several removals and replacements, the current drive designs become progressively less effective due to accumulated damage on the fastener and/or tool. This effort would develop, qualify, and implement an improved recessed fastener drive system capable of greater removal torque and damage tolerance. The improved drive system must enable the fastener to be qualified to the same structural, durability, and dimensional requirements of the current designs.

PHASE I: The Phase I proposal shall demonstrate a good understanding of the current situation and problem, present improved or unique approaches/design concepts, and establish a thorough action plan.

PHASE II: In Phase II the improved drive system will be further developed and laboratory and field tested. Phase III transition should be smooth given the number of uses of recess drive systems.

COMMERCIAL POTENTIAL: These type fasteners are used on all commercial aircraft and automobiles, and the same removal problems are experienced by their maintenance personnel also. An improved drive system will be of great benefit to the commercial and military maintenance teams and can be effectively used wherever recessed fasteners are utilized.

REFERENCE:
USAF Scientific Advisory Board Report "Aircraft Infrastructure-Subsystem and Component, Reliability Improvement, Research and Development Needs "F-A-C-T-S," September 1989

AF95-204 TITLE: Innovations for Aeronautical and Support Equipment FACTS Parts

CATEGORY: Basic Research
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop innovative approaches to improve the reliability/maintainability of existing FACTS components and Support Equipment.

DESCRIPTION: FACTS components make up the mechanical infrastructure of aircraft and support equipment. In contrast to the reliability gains in electronics and engines, the reliability improvements of FACTS items have been static. This topic covers all facets of aeronautical and support equipment FACTS parts research, development, and acquisition. It provides latitude to the innovator to investigate areas not addressed by other specific aeronautical or FACTS topics. Innovations to replace technologies that are currently available only from foreign sources or from limited sources in the United States are specifically encouraged. Proposals which address Logistic Technology Needs are encouraged. Some areas of interest are improvements to fastening systems and electronic connectors.

PHASE I: The Phase I proposal should address a good understanding of the current problems, identify potential solutions and the anticipated Phase II effort and potential for Phase III.

PHASE II: During Phase II the contractor should design, build, and test the proposed solution from Phase I.

COMMERCIAL POTENTIAL: FACTS items such as fasteners and connectors are common to both commercial and military aircraft and their associated support equipment. FACTS maintenance problems are generally the same for both military and

commercial operators. Improvements in the reliability and maintainability of military FACTS items, will have direct application to commercial aviation fleets. The goal of any proposed solution should be its acceptance as a commercial standard.

REFERENCES:

USAF Scientific Advisory Board Report "Aircraft Infrastructure-Subsystem and Component, Reliability Improvement, Research and Development Needs "F-A-C-T-S," September 1989

AF95-205 TITLE: Fracture Toughness Analysis of Metastable Beta Titanium Alloys

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Reliable, low-cost, high speed method of producing large panels of titanium alloys.

DESCRIPTION: A metastable Beta Titanium alloy (TIMETAL 21s) has been baselined into current designs of hypersonic vehicles for both structural members and skins. This alloy possesses high temperature capability and excellent room temperature ductility as well as superior corrosion and oxidation resistance. High speed welding of such materials may be necessary to achieve economical production of future hypersonic vehicles. Limited welding experience with this and like alloys indicates that fracture toughness in the weld and heat affected regions of the weld is markedly reduced. Research is required to produce large, thin (0.060) sheets as well as appropriate analytical approaches to predict ultimate fracture toughness.

PHASE I: Show experience and understanding of the relative importance of the technologies. Provide detailed drawings, specifications, and test procedures for the proposed application of the technologies.

PHASE II: Prototype and associated test results demonstrating strong welds, rapidly produced. Also demonstrate ability to predict ultimate fracture toughness in the welded joints.

COMMERCIAL POTENTIAL: The end product will be directly useful by the NASP Industry Team, Government laboratories, the automotive industry, and commercial aircraft manufacturers, anywhere welding of sheet titanium is done.

REFERENCES:

1. "Laser Welding of an Oxidation-Resistant, Metastable-Beta Titanium Alloy Beta 21S," P. S. Liu, K. H. Hou, W. A. Baeslack III, and J. Hurley.

AF95-206 TITLE: Emerging Technologies resulting in Lighter Aircraft, Increased Engine Performance, and Improved Design Tools

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Improve aircraft structure, scramjet performance, and aerodynamic design technologies.

DESCRIPTION: Emerging technologies providing significant performance improvements via new and innovative solutions for hypersonic aircraft will be considered. Computational fluid dynamics, materials science, and scramjet performance, particularly innovative, nonintrusive techniques to measure such engine parameters as wall shear, mass flow, temperatures, and pressures, inlet angel of attack, and exhaust water vapor content, are of special interest.

PHASE I: Show experience and understanding of the relative importance of the technologies. Provide detailed drawings, specifications, and test procedures for the proposed application of the technologies.

PHASE II: Prototype and associated test results demonstrating decreased weight, increased scramjet performance, or improved aerodynamic design tools without increased liabilities.

COMMERCIAL POTENTIAL: This technology will be useful to the NASP Industry Team, Government laboratories, the computer industry, the automotive industry, the aeropropulsion industry, and the aircraft industry.

REFERENCES:

1. AIAA 92-3955, CW Laser Strategies for Simultaneous, Multiparameter Measurements in High-Speed Gas Flows, DiRosa, Philippe, Arrova, and Hanson.

2. SPIEs OE/LASE '94, Water Vapor Measurements for Combustion Diagnostics Using a 1350-nm Tunable Diode Laser, Wang, Truco, Sachse, Campbell, and Davis.

AF95-207 TITLE: Armament Research

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop innovative concepts in areas associated with air deliverable munitions and armaments.

DESCRIPTION: New and innovative ideas/concepts and analysis methodologies are desired in the area of air delivered non-nuclear munitions and armament. These include bombs, submunitions, warheads, projectiles, fuzes (including safe and arm devices for air-to-air missiles), dispensers, seekers, explosives, carriage and release equipment, aerodynamic and structural technologies, fiber optics, solid-state inertial components, exterior ballistics, lethality and vulnerability assessment techniques, and conventional weapon environmental, demilitarization and disposal techniques. Some examples of desired research are: low drag/observable weapon airframes; conformal/internal carriage techniques; millimeter wave-seekers for mid-course and terminal guidance; sensor fusion; self-forging fragment warheads; shaped charges; long-rod penetrators; reactive fragment warheads; computational fluid dynamics including interactive grid-generation techniques, and warhead hydrocode- assessment techniques; hard-target weapon technology; and autonomous guidance.

PHASE I: During Phase I, the offeror shall determine the technological or scientific merit and the feasibility of the innovative concept.

PHASE II: The Phase II effort is expected to produce a well defined deliverable product or process.

COMMERCIAL POTENTIAL: Each proposal submitted under this general topic should have an associated dual-use commercial application of the planned technology. The commercial application should be formulated during Phase I. Phase II will require a complete commercialization plan.

Note: Any offeror who proposes tasks that involve the loading, handling, or storage of ammunition, explosives, and related dangerous materials, is required to meet the requirements of DOD 4145.26M, "DOD Contractor's Manual for Ammunition, Explosives, and Related Dangerous Material," before a contract can be awarded.

AF95-208 TITLE: Tunable Laser Radar

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop a tunable laser for military and commercial applications.

DESCRIPTION: A tunable laser would be an essential component of differential absorption laser radar which could be used for the remote assessment of automobile or factory emissions as well as the monitoring of atmospheric chemicals. It will be useful in both biological and chemical spectroscopy systems which can identify constituent components for medical and research applications. Current laser radar in military systems use a single laser frequency, either 0.85, 1.06, or 10.6 microns for GaAs, Nd:YAG, or CO_2 respectively. When these systems are in operation, the relatively high laser power output is easily detectable allowing for countermeasures such as smoke, fog, or a blinding laser return. If the operating wavelength of the system is known, it is possible to blind the seeker by overloading the detector element. In addition, current seeker systems do not take advantage of the wavelength sensitivity of potential targets and background.

The goal of this program is to design and develop a direct-detection tunable laser radar with a range of 1 kilometer and a minimum frame rate of 1 Hertz. The nominal field of view is 4 by 10 degrees which represents 40 x 100 pixels. A cross range resolution of 0.1 degrees and a range accuracy of 0.3 meter are desired. We envision that the wavelength can be kept relatively stable (plus or minus 0.1 micron) while collecting a frame, but that it can rapidly change when necessary (between frames). The wavelength should be continuously tunable over a band of 800 nanometer in the frequency range between 0.75 and 3.5 microns. The detection system should not require cryogenic cooling.

PHASE I: Phase I of this SBIR program should include the possible laser, detector, and filter requirements of the system, demonstrating the feasibility of critical technology, and a preliminary Phase II design.

PHASE II: Phase II should include building a prototype tunable laser radar system within the specifications given above. The system would be demonstrated on the Eglin range against targets in cluttered background.

COMMERCIAL POTENTIAL: Tunable laser systems are highly desired by the remote sensing community and have applications in areas such as pollution monitoring, and crop development monitoring. Components of the above system have additional commercial uses for spectroscopy in the scientific and industrial fields.

REFERENCES:
1. Wolfe and Zissis, "The Infrared Handbook", ERIM, Ann Arbor Press, 1989, P 11-68.

2. A. Jelalian, "Laser Radar Systems", Artech House, Boston, 1992.

AF95-209 TITLE: Detection of Buried Structures and Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop a penetrating sensor which can detect buried structures and objects in a variety of soils a nd geological materials.

DESCRIPTION: The Air Force has interest in developing a sensor system capable of identifying air voids, concrete materials, and metal materials associated with underground facilities. A desired concept would consist of a sensor mounted within a weapon that penetrated quickly through strata of materials. The sensor would provide, prior to impact and in real-time, information on the buried structure and its material composition.

PHASE I: Phase I of this program should include analysis, design, and modeling of the proposed sensor. Proof of principle laboratory experiments with a breadboard sensor are desirable. Phase I should include optimization of the sensor parameters, fabrication of brassboard sensors, and field tests against concrete, soil, and voids.

PHASE II: Phase II of the program would optimize the sensor parameters, fabricate, and collect real-time data in actual field test. These tests can be conducted at the sponsor's facility and would include actual gun launch through concrete and soil.

COMMERCIAL POTENTIAL: This type of sensor could have a variety of applications in mining, civil engineering, environmental engineering, archeology, transportation, and criminology industry. Detection and identification of minerals, estimation of structural and mechanical defects, locations and evaluation of buried contaminants, and applications to collision avoidance are partial list of potential utilization of this sensor. Sensors of this type could also be used by utilities and communication companies to locate obstructions and determine routes prior to installation of new underground cables, pipes, etc.

REFERENCES:
1. "Fourth International Conference on Ground Penetrating Radar" Edited by Hannien, P. and Autio, S., "Geological Survey of Finland, Special Paper 16", June 8-13, 1992.

2. "Third International Conference on Ground Penetrating Radar", Lakewood, Colorado, May 14-18, 1990.

AF95-210 TITLE: Optical Materials for Spatial Light Modulators

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Develop and test solid state materials for use in spatial light modulators.

DESCRIPTION: The Air Force has considerable investment in programs relating to optical processing and computing. Light modulation devices are used in many processing and computing applications. The materials used to bring about the modulation often have slow response times or require high voltages. Materials are needed which can modulate an optical beam rapidly using as low an applied voltage as possible. Response times of less than one microsecond and voltages of 50 volts or less are desired. Solid state materials (not to include liquid crystal materials) which modulate wavelengths from .4 to 12 micrometers are sought, although it is not intended that the same material cover this whole spectral region. Materials with good figures of merit for modulators should be considered. Eventual use of the materials in a two-dimensional spatial light modulator is expected.

PHASE I: Phase I is intended to be a survey of existing knowledge, theoretical development for prediction of performance potential of new materials, and demonstration of basic performance of proposed materials.

PHASE II: Phase II is to consist of development of new materials based on results of Phase I and the design and fabrication of a limited scale (128x128) pixelated device to function as a two-dimensional spatial light modulator.

COMMERCIAL POTENTIAL: Optoelectronic systems will become increasingly prevalent over electronic-only systems. The modulator materials developed here are not tied to a single application, but could be used in a wide range of commercial and

military robotic vision applications. Our primary application is optical pattern recognition. This is an application which has obvious commercial uses, some of which we are poised to exploit (e.g. factory automation, fingerprint identification, image data base search, medical image processing). In addition, this research will have important implications for optical computing, optical interconnects, and display technology.

REFERENCES:
1. W. E. Ross et al., "Reflected Magneto-Optic Spatial Light Modulator (R-MOSLM) Advanced Development for Miniature Ruggedized Optical Correlators (MROC)." Proc SPIE Vol 1959 P 222-229 (1993).

2. S.H. Lee et al., "Two-dimensional Silicon/PLZT Spatial Light Modulators; Design Considerations and Technology," Opt Eng. Vol 25 No. 2, P 250-260 (1986).

3. A. Wu et al., "Electro-Optic and Non-Linear Coefficients of (Pb.LA)(Zr,Ti)Q3, BaTiO3, (Sr.Ba)Nb2O6 and Ba2NaNb5O15 Thin Films," Mat. Res.Soc. Proc., Vol 200, P 261(1990).

4. J.A. Neff et al., "Two Dimensional Spatial Light Modulators; a Tutorial," Proc IEEE, Vol 78 No. 5, P 826-835 (1990).

AF95-211 TITLE: Pulsed Fiber Optic Laser

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Design and construct a small pulsed rare-earth doped fiber optic laser.

DESCRIPTION: Recent advances in the field of fiber optic communications have demonstrated the ability of an optical fiber doped with a rare-earth element and optically pumped by a semiconductor diode laser, or diode laser array to produce an amplified laser output. Developments of this type have concentrated on the needs of the communications industry: namely, fibers operating in a continuous wave output mode at low levels of laser power. The focus of this effort is to explore the possibilities and limitations of using these devices in a pulsed-power mode. The goal is a compact, low cost method of delivering an intense laser pulse of several megawatts of peak power and a pulse width of ten nanoseconds.

PHASE I: Phase I of this project should investigate the possibility of using different atomic elements for doping the fibers, different schemes of fiber construction, overall fiber dimensions, methods of Q-switching, and the allowable damage thresholds for these materials.

PHASE II: Phase II would involve constructing the fiber laser of the desired materials and design. The final units could be used either individually, or coupled together in a multiple fiber laser array to produce a final high energy output pulse with the desired characteristics.

COMMERCIAL POTENTIAL: This project concerns a very new and fruitful area of research which can benefit both industry, and the military. Any advances in this field could have an impact on the fiber optics communications industry, and the commercial laser industry, as well as applications in medicine, rocket motor ignitors, oil drilling, construction, and automotive airbag ignitors.

REFERENCES:
1. A. Glass, "Physics Today", Vol. 46, P 34 (1993)

2. H. Po, et al, "Electronic Letters", Vol 29, P 1500 (1993)

3. H. G. Park, W. W. Morey, & J. P. Waters, "Electronic Letters", Vol 26, P 1829 (1990)

AF95-212 TITLE: Process for Delivering Energetic Wastes to Molten Salt Destruction Reactors

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Mechanisms for safely introducing energetic materials into high temperature molten salt baths are required.

DESCRIPTION: Molten Salt Destruction (MSD) has been demonstrated as an effective means of destruction for hazardous wastes, including propellants and explosives, by Rockwell International Corporation and Lawrence Livermore National Laboratory. Substantial heating temperatures ranging from 400 degrees C to 1000 degrees C are required to melt a mixture of carbonate salts. Molten salts have large heat capacities that are able to accommodate the energy released during rapid decomposition of wastes containing propellants and explosives. However, reactions near the surface upon entry to the molten baths could be catastrophic. Delivery of the energetic wastes into the reactor during bench scale studies has been accomplished by: 1) top feeding the wastes in small batches using "french fry" baskets and submerging the wastes for treatment, or 2) injecting the wastes in liquid-based slurries near the bottom of the baths. This is accomplished under positive pressure at low contaminant flowrates (5lb/hr). New and innovative processes for safely increasing the throughput flowrate for larger reactors are required to expand this technology to pilot-scale operations for energetic materials. Safe delivery and subsequent molten salt destruction of energetic materials at flow rates up to 200 lb/hr is required. A feed system capable of delivering 1 cubic centimeter sized pieces of waste explosives/propellants and preprocessed contaminated wastes (paper suits, gloves, etc.) is needed.

PHASE I: The Phase I effort should focus on a proof of principle demonstration of a feed system capable of delivering wet or dry inert particles of the specified dimensions and flowrates into liquid reactor media without contaminating the feed system with the reactor fluid.

PHASE II: Phase II should result in demonstration of a hardware system capable of safely delivering energetic waste particles to a compatible 1000 degrees C molten salt bath reactor at contaminant flowrates up to 50 lb/hr. The system should be capable of operating at a turn down power of 10 lb/hr.

COMMERCIAL POTENTIAL: The technology developed under this program would position molten salt destruction as a viable alternative to incineration for large scale energetic waste disposal. This project supports all ordnance systems during their life cycle. Other methods of hazardous waste disposal are becoming severely restricted by the U.S. Environmental Protection Agency. Successful demonstration in the energetic materials arena could provide opportunities to employ molten salt reactors to cost effective treatment of medical wastes, municipal sewage sludge and other hazardous wastes in areas where incineration is restricted.

NOTE: An offeror who proposes tasks that involve the loading, handling, or storage of ammunition, explosives, and related dangerous materials, is required to meet the requirements of DOD 4145.26M, "DOD Contractor's Manual for Ammunition, Explosives, and Related Dangerous Material", before a contract can be awarded.

REFERENCES:

1. R. Upadye, et. al., "Energetic Materials Destruction Using Molten Salt," Proceedings of American Defense Preparedness Associations Demilitarization Symposium (Meeting #472). May 23-25, 1994.

2. R. Upadhye, et. al., "Destruction of High Explosives and Wastes Containing High Explosives Using Molten Salt Destruction Process," Proceedings of the 23rd International Annual Conference of ICT 1992 (Waste Management of Energetic Materials and Polymers).

3. Darnell, A.J., et. al., "Disposal of Explosives and Propellants by Use of Molten Salts," Annual Report, Atomics International Report No. AI-73-28, June 1973.

AF95-213 TITLE: Environmental Effects of Tungsten and Tantalum Alloys

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Determine environmental effects of tungsten and tantalum alloys.

DESCRIPTION: The use of tungsten and tantalum alloys by commercial industry and DoD is impacted by the continually changing Federal, State and local government laws and regulations governing activities because of potential environmental implications. Current armor defeating warhead/penetrator technology is being focused on use of tungsten and tantalum alloys. The materials tungsten and tantalum, by themselves, are not very toxic and are believed to cause very little, if any, environmental effects when released into the environment. However, when these materials are alloyed with other materials such as cobalt cemented tungsten carbide, then the toxicity of cobalt becomes a matter of concern. This effort is to investigate the environmental implications of using tungsten and tantalum alloyed with other materials. Some information on warhead/ penetrator materials can be provided during Phase I.

PHASE I: Phase I will involve investigating and characterizing tungsten and tantalum alloys of interest to the DOD, and identifying the potential environmental effects of the alloys, both short-term and long-term.

PHASE II: Phase II will involve incorporating the information into a data base for use by researchers in selecting materials and predicting the potential environmental effects.

COMMERCIAL POTENTIAL: Tantalum is used in a variety of applications such as pen points, analytical weights, instruments for medical use, and electronic capacitors. Tungsten is used in many areas such as steel manufacturing, light bulb filaments, automotive parts, and phonograph needles. Tungsten carbides are used in rock drills, metal-cutting tools, wire-drawing dies, and as a catalyst instead of platinum. The wide scope of industrial use of these two materials suggest a ready market for a materials selection database. Data on environmental effects of tungsten and tantalum alloys would be helpful in the selection of locations and design of manufacturing facilities and in environmental compliance management at existing sites.

AF95-214 TITLE: High Speed Charge Coupled Device (CCD) Signal Processing and Data Acquisition Chip Set

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a chip set for high speed CCD signal processing and data acquisition.

DESCRIPTION: The technologies for an ultra high bandwidth, high speed imaging system (high resolution, high speed CCD, 1024 pixel by 1024 pixel at 1000 frames per second) are currently being developed for munitions testing. In order for this technology to be fully utilized in DOD applications, new support electronics must be developed in parallel. The requirements call for parallel processing of up to thirty-two channels of data at a channel data rate of 375 megabits per second. The processing requirements begin with clock generation coupled with the necessary drive circuitry which will provide the CCD with all of the necessary wave forms for proper operation. This would include a 10 MHz square wave train capable of driving 4000 picofarad and 50 MHz square wave train capable of driving a 50 picofarad load. Also needed is the ability to adjust both clock phases and clock levels. Other control signals, such as reset, would not have the speed or drive requirements, but should be level adjustable. Other requirements are for post-CCD processing with the major requirements centering around analog-to-digital (A/D) conversion. Also included should be the required pre-A/D signal conditioning such as correlated double sampling or peak stretching circuitry which would allow accurate sampling with minimal noise. The CCD and support electronics will be confined to a cylindrical form with a five inch diameter and twelve inch length. In consideration of this, there is a requirement for extremely low power dissipation to prevent excessive heating. With the multi-channel operation, cross talk should be minimized to the fullest extent.

PHASE I: Phase I should be a completed design of the Application Specific Integrated Circuits (ASICs) with chip and system level packaging addressed.

PHASE II: Phase II would include fabrication and implementation of the Phase I design to produce prototype cameras.

COMMERCIAL POTENTIAL: This type of integrated circuit is key for all of the desktop graphics input devices that are becoming available. It is also critical data acquisition technology for most, if not all, of the high resolution medical imaging devices such as MRI, CAT, and PET scanners. In addition, it has data acquisition application in the automotive, commercial aircraft, and industrial testing community.

REFERENCES:
McCurin, Schooley, and Sims, "Signal Processing for Low-Light-Level, High Precision CCD Imaging", SPIE Vol 1448, "Camera and input Scanner Systems" (1991).

AF95-215 TITLE: Optimal Design of a Methodology for Complex, Nonlinear, Multidimensional, Noninterdependent, Multivariable System Using Nonlinear Programming

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop a computational method for the optimal design of complex, nonlinear, multidimensional, noninterdependent, multivariable system.

DESCRIPTION: At present, the design of complex multivariable systems consisting of a wide range of noninterdependent parameters (such as hard target penetration or multimode warhead formation) is accomplished by a combination of range testing

and simulation. A "trial and error" approach is most often used to find an optimal design, which is found by changing, in the penetration problem, the nose shape, penetrator length, weight, case material, and target material models. This method results in a series of range test and simulation calculations; both methods can be very expensive. There is currently no method of using the mathematics of nonlinear mathematical programming to find an optimal design in a minimum number of iterative steps. Successful completion of this program would result in the ability to perform design studies at greatly reduced cost and would contribute to the state-of-the-art in the science of optimization.

The problem of Air Force interest consists of a metallic penetrator filled with explosives striking and interacting with a reinforced concrete target. The product desired from this effort would be a computational method to perform the optimal design of a penetrator, subject to given equality and inequality constraints. The product would be compatible with existing simulations and when modularity contradicts would be easily adapted to other codes. The FORTRAN programming language must be used.

PHASE I: Phase I of this effort would consist of a concept exploration of the methods of nonlinear programming applicable to problems of this class of complexity. Both direct and indirect methods of nonlinear optimization should be considered at this stage.

PHASE II: Phase II would consist of the development of a computer program to solve the optimization problem using the selected method and a demonstration of its use for a limited class of problems (penetration oriented).

COMMERCIAL POTENTIAL: This program would advance the state-of-the-art in numerical nonlinear optimization. This technology is being applied in many design areas: aviation and bridge construction, automotive fuel control/mileage improvements and minimization of pollutants, manufacturing plant control for production, and results in improved safety and performance while reducing design costs and time.

REFERENCES:

1. Gans, H.D. and Anderson, W.J., "Structural Optimization Incorporating Centrifugal and Coriolis Effects", AIAA Journal, Vol 29, No. 10, Oct 91, Pgs 1743-1750.

2. Miki, M. Sugiyama, Y., "Optimum Design of Laminated Composite Plates Using Lamination Parameters", AIAA Journal, Vol 31, No. 5, May 93, Pgs 921-922.

3. LeRiche, R., and Haftka, R.T., "Optimization of Laminate Stacking Sequence for Buckling Load Maximization by Genetic Algorithm", AIAA Journal, Vol 31, No. 5, May 93.

AF95-216 TITLE: <u>High Intensity Illumination System (HIIS)</u>

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Produce a high intensity light source for ultra-high speed photography of explosive/projectile events.

DESCRIPTION: Explosively driven argon filled tubes (argon candles) are currently the only practical high intensity long duration lighting source for ultra-high speed photography of explosive events. Film or electronic streak and framing cameras used for explosive and ballistic studies run at frame rates from 10 thousand to 20 million frames per second. Total event times are typically from microseconds to a few seconds. Argon candles provide uneven illumination profiles, are difficult to precisely control, complicate the test setup, and contribute to additional safety hazards. The HIIS illumination system should provide sufficient amount of illumination and duration for ballistic and explosive photography. The high illumination source must flood out the light from the explosive event, provide sufficient illumination for ultra-high speed photography and have an adjustable duration. The design of this system should make the system portable and sturdy for range testing. The source should provide light in the sensitive range of film and electronic imaging devices without large amounts of IR radiation. The source(s) should provide either synchronous pulsed or continuous illumination capability for different type camera systems.

PHASE I: Phase I shall define and demonstrate potential techniques to apply this technology at test ranges beyond the lethal range. The tasks will provide a preliminary system design(s), proof of principal tests comparing results to existing techniques and recommendation of a candidate approach to be demonstrated in Phase II.

PHASE II: The Phase II task will prototype an illumination system and demonstrate its performance with an ultra-high speed imaging system for fragmentation, explosive shock wave propagation, and shaped warhead formation. It is anticipated that most of the testing and demonstration will be performed at Wright Laboratory facilities at Eglin AFB FL.

COMMERCIAL POTENTIAL: Argon candles and banks of high voltage intensity flood lights used in industrial crash testing are hazardous and expensive to use. This light source can and will be commercially marketed to replace these large and hazardous light sources. The HIIS has potential uses in explosive mining and high speed machining or manufacturing process failure studies.

REFERENCES:
Jones, C.R. & Davis, W.C. (1982). "Optical Properties of Explosive Driven Shock Waves in Nobel Gases." LOS ALAMOS REPORT LA-9475-MS, Sep 82.

AF95-217 TITLE: Non-volatile Shock Recorder

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Develop a data recorder for monitoring of impact and penetration events at environmental extremes.

DESCRIPTION: The Air Force has pioneered the development and use of digital data recorders for monitoring ordnance events, i.e., munitions acceleration/deceleration and fuze function. Recent advances in non-volatile memory devices (Electronically Erasable Programmable Read Only Memory - EEPROM), high energy capacitors (e.g., supercaps, ultracaps, etc.) and packaging technology (e.g. multi-chip module) offers the potential for correcting the deficiencies of existing recorders. These include loss of data due to battery failure, inoperability at temperature extremes (-65 degrees F to + 160 degrees F), eight bit data resolution and volume constraints.Desired characteristics are: up to four, eleven bit analog channels; up to eight digital channels; storage capacity of 128K bytes per analog channel and 32K bytes per digital channel; and non-volatile data retention. In addition, the recorder must be 100kg shock survivable, be contained within one cubic inch, have no more than one cubic inch for the power supply, operate between - 65 degrees F, to + 160 degrees F and have personal computer (PC) compatible data retrieval.

PHASE I: Phase I of the effort should include initial design and test of proposed component types to indicate temperature and shock survivability.

PHASE II: Phase II of the effort would consist of final design, fabrication and test of complete recorder systems, and delivery of five recorders for Air Force evaluation.

COMMERCIAL POTENTIAL: This project will have significant payoff in both the military and commercial sector. Existing recorders have proven their value in weapon development, product shipment monitoring and auto and aircraft crash testing. This project will extend this valuable capability to cover temperature extremes in smaller volumes coupled with data retention after power failure.

AF95-218 TITLE: Ultralow Impedance High Voltage Connector

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop an ultralow Impedance High Voltage Connector

DESCRIPTION: Advanced technology detonators such as the Exploding Foil Initiators (EFI) have suffered from the limitation of not having an efficient and reliable connection method for applications requiring separation of the EFI from the rest of the firing system. To maintain total firing system efficiency the connector must have minimal inductance and resistance. There are two basic types of connectors of interest for the detonator applications involved. The first type of connector must connect to flat cable striplines as used in most EFI firing systems. The second type is for connecting to other advanced detonators (Semiconductor Bridge Detonator, SCB) that are expected to have coaxial style connection leads. Both types of connectors will be required to have a hermetic environmental seal. The fundamental goals of this program are to improve connector technologies for small sized commercial and military applications requiring low loss/low impedance transmission lines. The technical challenge is to formulate concepts for unique connector configurations and determine effective materials to meet electrical requirements and hermetic sealing requirements for small size products requiring rapid discharge of stored electrical energy. The benefit is higher efficiency energy transfer allowing smaller size/lower power systems for commercial and military use in a wide range of products such as stun guns and electromagnetic pulse generators proposed for use as nonlethal weapons.

PHASE I: Phase I of this program should include formulating connector concepts for flat cable and coaxial designs, analyzing the concepts, selecting the most favorable concepts for experimentation in Phase II, and fabricating a selected preliminary design for limited breadboard evaluation. A thorough understanding of technologies for hermetic sealing including glass-to-metal seals is required.

PHASE II: Phase II of the SBIR task is expected to involve design, fabrication, and test of all concepts recommended from Phase I. This will involve materials development/selection for conductors and insulators, development of fabrication techniques, and fabrication for evaluation using selected materials. Several design iterations are expected to determine the most effective alternatives for flat cable and coaxial configurations.

COMMERCIAL POTENTIAL: The commercial applications include pulsed power cable connections, high voltage connectors for high altitude applications, power supply connections, nonlethal weapons, and security systems.

REFERENCES:
"An Alternate Interconnect Method of Joining Flexible Circuits Using Conductive Adhesives", EG&G Mound Applied Technologies Report No. MLM-3631, April 1990.

AF95-219 TITLE: Two-Dimensional Avalanche Photodiode Arrays

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop two-dimensional silicone (Si) avalanche photodiode arrays on near-infrared long range LADAR application.

DESCRIPTION: Since 1986, the Armament Directorate has pursued the development of compact, low-cost, diode-pumped solid state laser radar for use as seekers in air-to-air and air-to-surface munitions. These systems are primarily intended for use in short to medium range systems where one Si Avalanche Photodiode (APD) or a linear array of up to 25 APDs is for detection. Generally, one of the most common design tradeoffs in a LADAR system involves trading range of the system versus cross range resolution and frame rate. The cross range resolution determines the number of pixels in the frame and the limit of the laser pulse repetition frequency (PRF) determines the frame rate. Ultimately, laser power has to be traded against laser PRF. When very high frame rates are desired along with long range performance, the requirements on the laser become so great that the laser becomes prohibitively expensive. Using an APD array, with lower PRF but higher peak power and higher pulse energy lasers (which are commercially available) it is possible to obtain very high frame rate, long range LADAR.

PHASE I: Phase I of the SBIR should include the design of an APD array and the associated detection electronics and demonstrating the technical feasibility of the detection scheme by either a direct demonstration or a simulated circuit. The system should be a minimum of 25 by 25 pixels, each with its own range circuitry. The APD array should be able to collect and process data at a 1 kHz frame rate. The bandwidth of the detector should be at least 350 MHz with 1 GHz desired.

PHASE II: Phase II of the SBIR effort includes fabricating the APD array and demonstrating its ability to capture and process LADAR data in a bench top LADAR system operating at a kHz frame rate. A possible follow-on effort would include fabricating and testing a fully flight ready LADAR system based on the APD prototype.

COMMERCIAL POTENTIAL: The development of 2-D Avalanche photodiode arrays would revolutionize the use of laser radar for commercial applications. It would allow laser radar to operate like a video camera, but with extremely high frame rates far exceeding any commercial high speed photographic systems (up to 150 kHz if desired). This would allow imaging laser radar to replace many existing systems that are currently video based or imaging infrared.

REFERENCES:
1. H. Melchoir, et al, "Photodetectors for Optical Communication Systems", Proc IEEE, 58 (10), Pgs 1466-1486.

2. Johnson, "IEEE Trans Electron Devices", ED-12, Pgs 55-63 (1965).

3. Wolfe and Zissis, "The Infrared Handbook", ERIM, Ann Arbor Press, 1989, Pgs 11-68.

AF95-220 TITLE: Efficient Methods for Finite Element Data Storage

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop highly efficient methods of storing and manipulating finite element data.

DESCRIPTION: The finite element method is used in a wide variety of engineering applications such as the Lagrangian-hydrocode employed by the Computational Mechanics Section of MNMW. The development of highly efficient methods for data storage and manipulation could greatly reduce the storage and computational requirements of these codes. The use of finite element methods in three dimensions requires the use of large amounts of data related in complex ways. The manipulation of this data accounts for much of the storage requirements and programming logic of current codes. The development of more efficient methods for storing and manipulating data could result in faster and more accurate hydrocodes.

PHASE I: In Phase I the contractor shall analyze current data handling schemes, examine how data is stored and handled in existing hydrocodes and proposing a new highly efficient handling scheme.

PHASE II: Phase II will be the implementation of the selected method for data storage and manipulation in a selected hydrocode. The FORTRAN programming language should be used.

COMMERCIAL POTENTIAL: The methods developed in this effort could be used in a wide variety of finite elements codes in use throughout the scientific and engineering community. New methods are directly applicable to a whole range of industrial codes requiring finite element analysis.

REFERENCES:
G. H. Golub, "Matrix Computations", The John Hopkins University Press, 1990.

AF95-221 TITLE: An Improved Method of Determining the Equations of State of Concrete and Geological Materials

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop improved test and method of modeling methods for determining the equations of state of concrete and geological materials.

DESCRIPTION: In order to perform numerical hydrocode simulation of weapon penetration into concrete and rock material, it is important to know the equation of state of the material for a wide range of strain rates. At present, there is very little data available for the creation of these equations of state models. Using present techniques for testing the materials, obtaining large amounts of data across wide strain rates is very expensive and time consuming. The proposed method for developing equation of state models has application to penetrating warhead design, earthquake survivable construction designs, design of flood control structures, and design of underground structures and mining.

PHASE I: Phase I of this program would involve the concept exploration of a testing method that would obtain the required strain rate concrete data suitable for use in an improved concrete model. Phase I should include an analysis of the current state-of-the-art in concrete testing as well as proposed solutions to more efficient test and modeling of the strain rate behavior of concrete.

PHASE II: Phase II would consist of engineering development of the testing method resulting from the Phase I study, testing of concrete samples, and the use of the test data to verify the strain rate concrete model. The result of this effort would include a demonstration of the feasibility of the method using actual concrete tests.

COMMERCIAL POTENTIAL: Successful development of improved methods of concrete testing would lead directly to greater reliability and improvements in the national economic infrastructure in areas such as bridges, roads, dams, and other concrete structures particularly in earthquake prone areas.

REFERENCES:
1. L. H. Bakken and P. D. Anderson, "An Equation of State Handbook", Sandia SCL-DR-68-123, Jan 1969.

2. Chinn, J. and Zimmerman, R. M., "Behavior of Plain Concrete Under Various High Triaxial Compression Loading Conditions, AFWL-TR-64-163, Aug 1968.

AF95-222 TITLE: High Power Diode Driver Development

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop compact high power diode drivers for short range low-cost semiconductor diode laser radar (LADAR).

DESCRIPTION: Since 1986, the Armament Directorate has pursued the development of a compact, low-cost, solid state laser radar for use as a seeker on air-to-air and air-to-surface munitions. This development has pursued two options: direct diode LADAR for shorter range, lower cost applications; and diode-pumped solid state LADAR for longer range, higher cost applications. Diode lasers have improved steadily over the years, with improvements in beam quality, peak power, and pulse energies. At the same time costs for these devices continue to drop. The development of compact diode drivers has not kept pace with the diode development, being limited to 100 amp peak currents at slower than desired rise and fall times. In order to provide the power requirements for direct diode LADAR, a diode driver with the capability to provide 200 amps of peak current is

required, with 500 amps desired. The pulse widths need to be in the range of 3 to 20 nanosecond, with 1 to 10 nanosecond desired. The pulse repetition frequency must be at least 10 kilohertz, with 20 kilohertz desired. The overall package size for the driver should be less than 27 cubic inches. The package should be designed to minimize electro magnetic interference effects on the range board and detector electronics to be located close to the driver package. It is required that the driver should not interfere with sensitive detector/ranging electronics operating one foot away from the driver (in open space) and it is desirable to have the driver located one or two inches away from the detector/ranging electronics.

PHASE I: A Phase I SBIR should include the driver package design and identification of the design tradeoffs used to specify the Phase II design objectives. Phase I would also demonstrate the technical feasibility by either a direct demonstration or a simulated circuit.

PHASE II: The Phase II program would assemble and test the design that was developed in Phase I. During the Phase II testing the driver would be operated in a realistic seeker setting alongside seeker electronics. The performance of the direct-diode LADAR would be measured in relation to the driver performance.

COMMERCIAL POTENTIAL: The development of high power diode drivers would revolutionize the use of laser radar for commercial applications. It would allow laser radar to obtain longer ranges at a lower cost for commercial airline wind shear detection, drug detection, air pollution spectroscopy, and ship clearance testing, all at a low cost. This would allow imaging laser radar to replace many existing systems that are currently video based or imaging infrared based.

AF95-223 TITLE: Terradynamic Performance Improvements

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Develop a methodology for determining the penetration path, optimum shape and velocity restrictions associated with non-cylindrical earth penetrators.

DESCRIPTION: In earth sensors and data collection, probes can be installed using penetrating devices containing instrumentation packages. Earth excavation and open pit mining use the near simultaneous detonation of multiple charges to cause collapse of large segments of earth. Placement of charges could be accomplished using small penetrators containing electronics and explosive charges. Air Force interest in hard target penetration could be significantly advanced by reserach into the parameters associated in terradynamic performance of various penetrator shapes. New terradynamic shapes need to be developed, tested and modeled in prediction simulations in order to improve the stat-of-the-art in earth/rock/concrete penetration.

PHASE I: Phase I will consist of analysis of possible terradynamic shapes, examination of their relative advantages/disadvantages and recommendations of shapes to be fabricated and tested in Phase II.

PHASE II: Phase II will consist of fabrication of the designs from Phase I and small scale engineering testing of the concepts and development of a simulation model.

COMMERCIAL POTENTIAL: Improvements in terradynamic shapes could have potential payoff in the areas of seismic testing, excavating, pit mining, drill bit design and innovative new oil and natural gas drilling techniques. This technology could also be used in the development of more efficient and faster methods of tunneling.

Note: Any offeror who proposes tasks that involve the loading, handling, or storage of ammunition, explosives, and related dangerous materials, is required to meet the requirements of DOD 4145.26M, "DOD Contractor's Manual for Ammunition, Explosives, and Related Dangerous Material," before a contract can be awarded. In addition, it is desired to keep the Phase I program unclassified, although some knowledge of classified targets may be necessary in Phase II. It will be necessary for the contractor to maintain a secure facility and personnel clearances in Phase II when working with classified information.

AF95-224 TITLE: Environmental Fate and Remediation of High Explosive Residue

CATEGORY: Basic Research
DOD TECHNOLOGIES: Environmental Effects
AIR FORCE TECHNOLOGIES: Environmental Quality

OBJECTIVE: Determine the environmental fate of explosive materials released into the environment and develop remediation strategies.

DESCRIPTION: Historically, high explosives (HE) have been tested and disposed of by open burn/open detonation (OB/OD) in an open air environment. Most of the research conducted in the past has been on the fate and transport of HE in air. However,

the fate and transport in soil, sediment, and water is not well defined. This effort is to investigate the environmental fate of explosive materials released into the environment (excluding the air) and their degradation products and to demonstrate better ways to test, recycle or dispose of these materials and to remediate sites contaminated by the materials. Examples of explosives that have been used at the sites to be studied include common military explosives such as: 2,4,6 - trinitrotoluene (TNT), cyclo-1,3,5 - trimethylene - 2,4,6 -trinitramine (RDX or cyclonite), cyclo-1,3,5,7 - tetramethylene - 2,4,6,8 - tetranitramine (HMX), and explosives undergoing research and development by the Air Force, usually designated by the letters AFX followed by a number such as AFX 644.

PHASE I: Phase I of this effort will consist of analysis and identification of known Department of Defense (DOD) HE sites for further study and characterization, the collection of samples from a limited number of these known test sites, and analysis of samples for identification and characterization of HE residues. Eglin AFB test ranges should be included as test sites.

PHASE II: Phase II will use information gained from Phase I to determine toxicities of the residues and develop techniques to neutralize and remediate contaminated sites and demonstrate these technologies.

COMMERCIAL POTENTIAL: The commercial payoff of this technology will be in the development of a predictive capability for the environmental fate of HE and its degradation products, reduced monitoring and clean-up cost, reduced treatment/disposal costs and minimized environmental impacts to such industries as mining/quarry, demolition, seismic mappers, construction, civilian explosive test facilities/ranges, pyrotechnic/private arms factories, explosive metal forming, and foreign governments.

Note: Any offeror who proposes tasks that involve the loading, handling, or storage of ammunition, explosives, and related dangerous materials, is required to meet the requirements of DOD 4145.26M, "DOD Contractor's Manual for Ammunition, Explosives, and Related Dangerous Material," before a contract can be awarded.

AF95-225 TITLE: Blast Methodology for Vulnerability Models

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Improve existing closed-form internal blast methodologies typically found in hardened structure vulnerability analysis.

DESCRIPTION: The end product of this effort would provide a useful tool to the safety and structural engineer to predict the damaging effects of propagation of accidental or intentional explosions. An improved blast methodology for detonations inside fixed, hardened structures is needed that is robust and provides a realistic assessment of blast propagation throughout a multi-room hardened structure. Existing blast methodologies within vulnerability codes are empirically-derived and have limited capability for addressing the complex environment of an internal detonation. The use of simplified physics-based models to describe the internal blast environment can provide an avenue which is robust with marginal increases in computer processing time. These simplified models must account for pressure enhancement due to multiple reflections, time-varying loading effects on concrete walls, weapon fragmentation, breach hole formation and subsequent venting, and the quasi-static blast environment throughout the structure.

PHASE I: The Phase I effort should address the initial development of a simplified physics-based modeling approach which assesses breach hole formation and venting to an adjacent room. A recommendation of the best approach(es) to follow and a demonstration of capability should result from the Phase I proof of concept.

PHASE II: The Phase II effort would result in implementing the methodology into an existing hard target vulnerability model.

COMMERCIAL POTENTIAL: As the civilian population encroaches on areas of construction, mining, and explosive storage, the need to predict secondary effects from an accidental explosion increases. This effort would improve the prediction methodology.

REFERENCES:
1. Kinney and Graham, "Explosive Shocks in Air", springer-Verlag, New York, Inc., 1985.

2. Henrych, Josef, "The Dynamics of Explosion and Its Use", Elsevier Publishing Co., New York, 1979.

AF95-226 TITLE: Fundamental Electrode Research

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Define the catalytic activity of high surface area electrodes which are stable in aqueous sulfuric acid electrolyte.

DESCRIPTION: Although high surface area electrodes have been used to great advantage in several electrochemical applications, there is insufficient knowledge of the mechanisms involved with their catalytic behavior. Present models do not account for photoelectrolytic activity and do not address photoelectrochemical stability in aqueous electrolytic acids of high ionic conductivity. Basic research toward an increased understanding of stable oxide coatings on metal substrates is needed to better define the electronic properties of the coating/substrate interface.

PHASE I: Phase I would involve fabrication and testing of favorable materials and coating processes in order to evaluate resulting electrode catalytic activity and stability.

PHASE II: Phase II would advance this technology towards development of stable photoelectrolytic devices.

COMMERCIAL POTENTIAL: This technology will lead to new processing methods for efficient production of hydrogen via photo-assisted electrolysis of water. In addition, there is potential for development of a new family of photosensors as well as improved energy storage capacitors for a wide variety of military and commercial applications.

AF95-227 TITLE: Unconventional Payloads for Munitions

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Munitions Devices & Energetic Systems

OBJECTIVE: Development of unconventional payloads for munitions that will greatly improve present target defeat or access denial capabilities.

DESCRIPTION: Counter proliferation requirements, with minimal collateral damage, have lead to the need to develop new payloads for conventional hard target munitions. Payloads need to be developed which can neutralize or deny access to biological, chemical or nuclear weapon production and storage facilities. These payloads may also have application to agriculture or hazardous material needs relative to neutralization of undesirable substances.

PHASE I: Phase I will consist of analysis of possible unconventional payloads, examination of the defeat/denial mechanisms and possible implementation strategies, and recommendations of mechanisms to be fabricated and tested in Phase II.

PHASE II: Phase II will consist of fabrication of the designs from Phase I and small scale engineering tests of the concepts.

COMMERCIAL POTENTIAL: In additon to potential agricultural and hazardous materials uses, this technology could be applied to nonlethal weapons for use by law enforcement and security agencies, and special operations forces. Other potential applications include anti-terrorism, riot control and drug law enforcement.

Note: Any offeror who proposes tasks that involve the loading, handling, or storage of ammunition, explosives, and related dangerous materials, is required to meet the requirements of DOD 4145.26M, "DOD Contractor's Manual for Ammunition, Explosives, and Related Dangerous Material," before a contract can be awarded. It is desired to keep the Phase I program unclassified, although some knowledge of classified targets may be necessary in Phase II for design purposes. It will be necessary for the contractor to maintain a secure facility and personnel clearances in Phase II when working with classified information.

AF95-228 TITLE: Linear Motor Actuator

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Propulsion & Vehicular Systems

OBJECTIVE: Develop a low cost demonstration model of a Linear Motor Actuator (LMA) for flight control system application.

DESCRIPTION: The application of the Power-By-Wire (PBW) actuators eliminates the large central hydraulic systems and a major part of the hydraulic hazardous fluids. Total elimination of these fluids is possible with an LMA. The basic LMA consists of an actuator barrel with fixed electric driving coils, an actuator rod, and guide bearings. The control is accomplished by software and an associated computer. In this configuration this type of actuator lends itself to the two-level maintenance concept. The intent of this program is to demonstrate the applicability of the linear motor as an actuator in the aerospace environment.

PHASE I: Investigate the feasibility of LMA to increase the power-volume ratio. This desired ratio based on present day hydraulic flight control actuators is 20 hp/cu ft. The basic performance requirements for the LMA are stroke 13.75 inches (+/-6.875 inches) at a no load rate of 7.3 in/sec; frequency response 3 Hz; maximum output force 3000 pounds; and a back

drive force of less than 125 pounds at 1.0 in/sec. A conceptual design of the LMA and its control system will be developed based on an input voltage of 270 VDC. Provisions will be made to vary the basic parameters, except the physical limitations of the stroke 13.75 inches. Preliminary heat-generation calculations shall be performed and a heat rejection scheme shall be developed for a maximum ambient temperature of 160 degrees F. Finally, a work plan for Phase II shall be developed.

PHASE II: Phase II work includes a more in-depth analysis/design and the fabrication of an LMA and its control system. This system does not have to be flight worthy hardware. The actuator itself shall have attachment points for testing and imbedded thermocouples where required. This unit will be subjected to loads associated with flight control actuators, but the control system can be a bread board system.

COMMERCIAL POTENTIAL: The potential success of this dual-use technology will revolutionize aircraft actuation for military and commercial applications. The simplicity of the actuator will make it suitable for 2-level maintenance and the potential reliability can be very high. It is intended that Wright Laboratories (WL/FIG) is fully involved with the evaluation of Phases I and II of this program.

AF95-229 TITLE: Jet Engine Fuel Tubes and Manifolds Clearing and Cleaning

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Chemical & Biological Systems

OBJECTIVE: Develop reliable coke removal method for fuel tubes and manifolds. Accurately measure the tube or manifold wall thickness after cleaning.

DESCRIPTION: One product of jet fuel combustion is a hard, black substance called coke. Jet engine fuel tubes and manifolds build up coke and are frequently blocked by this substance from normal operation of the engine. This build up and/or blockage causes a reduction in engine efficiency and possibly premature engine removal and retirement of the tube/manifold. Chemical removal methods have met limited success, but have been unable to clean completely blocked tubes and are also undesirable due to their environmental impact. The abrasive flow method of cleaning has been successful, but tends to remove tube parent material and thus thins the tube wall causing a reduction in structural stability and cannot clean tubes that are completely blocked. Moreover, there is no reliable or expedient method to measure tube wall thickness after cleaning. Fuel manifolds and tubes are generally manufactured from stainless steel, inconel and titanium and are consequently quite expensive. The cost to replace blocked or badly coked tubes and the effects of chemical cleaning methods on the environment justify the need to develop an innovative mechanical method to clear and clean blocked fuel tubes and manifolds and to measure the effect of the cleaning on the tube wall thickness.

The technology required to remove coke from a jet engine fuel tube will require development of some type of abrasive, cutting tool or other suitable method that is capable of removing a substance that borders on having the same hardness as a diamond. Additionally, the method employed must be capable of following the complex shape of a fuel shape that renders current methods of mechanical cleaning unsuitable. Furthermore, it is imperative that a method be developed to accurately measure the wall thickness of a tube without destroying the tube. As with the cleaning method, the inspection method must be able to access the internal area of the tube that has been cleaned in order to accurately determine service condition.

PHASE I: Develop mechanical methods to open and clean a blocked tube and manifold, defining which geometrical configurations of tubes can be cleaned and, if necessary, measured.

PHASE II: Build prototype for use in a high volume repair environment.

COMMERCIAL POTENTIAL: All jet engines experience the clogging of fuel tubes as a result of coking.

REFERENCES:
Technology Transition Office, Technology Transfusion Information Program, Tech Tip No. 91082 "Permanganate Rejuvenation System", 8 Nov 91 (AFMC, WPAFB, Dec 1992)

Technology Transition Office, Technology Transfusion Information Program, Tech Tip No. 92092 "Abrasive Flow Cleaning" (AFMC, WPAFB, Dec 1992)

Bill Sweetman, "G.E. Say No to Coke," Popular Science, Sep 93, p.37.

AF95-230 TITLE: High-Dynamic, Multi-Configurable, Flight-Reference System

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Navigation, Guidance & Vehicle Control

OBJECTIVE: Develop miniaturized hardware, and software configurations that emulate flight reference systems in higher dynamic flight scenarios.

DESCRIPTION: The Central Inertial Guidance Test Facility (CIGTF), Holloman AFB, NM tests Inertial Navigation Systems (INS) that have embedded Global Positioning Systems (GPS) receivers. Precision flight tests of these systems require accurate position, velocity, and altitude information against which the test system can be compared in order to determine accuracy. Currently, there are systems in use that have limited dynamic capabilities and are rather large. Innovations are required to identify pieces of hardware that are capable of performing very accurately in a high dynamic environment (8-10 g) that can be packaged in one-tenth the volume currently required (Approximately 15 cubic feet).

PHASE I: Research culminating in the identification of candidate components to replace current flight reference system sensors that are capable of high dynamic operations and that may be packaged in a volume one-tenth that currently used.

PHASE II: The output of this phase will be a complete set of integration drawings (mechanical and electrical), a complete design of the system software (Ada programming language required), and a preliminary analysis as to the performance capabilities of the system in 3 different flight scenarios supplied by the Air Force.

COMMERCIAL POTENTIAL: Potential exists in the commercial inertial industry, laboratory research programs, and the commercial airline industry.

REFERENCES:
46th Guidance Test Squadron Capabilities Brochure (POC: Dr. Hooser, (505) 679-1757, DSN 349-1757).

Sub-meter Accuracy Reference System Development Plan, Nov 93 (POC: Dr. Hooser (505) 679-1757).

AF95-231 TITLE: Hypersonic-Vehicle Thermal Protection for High-Temperature Oxidizing Environments

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop analytical techniques to predict heating rates and apply state-of-the-art thermal protection to hypersonic rocket sleds.

DESCRIPTION: Adequate thermal protection of vehicles operating at hypersonic speeds is becoming more important as track customers require ever increasing test velocities. Operation with recovery at high Mach numbers and impact velocities above Mach 10 have been requested. It is necessary to be able to predict the heating rates that various sled components will experience on a typical recovered or non-recovered test, and to adequately protect the sled under these conditions.

PHASE I: Develop and validate analytical techniques that can be used by the Test Track to predict heating rates and temperature effects at hypersonic speeds for typical sled configurations. Develop valid temperature measurement techniques.

PHASE II: Develop and test candidate state-of-the-art thermal protection materials and attachment techniques for protecting critical areas of the rocket sled. These materials and attachment techniques must be light weight and not add significant frontal area to the rocket sleds.

COMMERCIAL POTENTIAL: Thermal protective materials developed by this effort will be directly applicable to NASA developments for high speed ground transportation and hypersonic ari transportation. The technology is also directly applicable to commercial air transportation and satellite missile-launch capabilities, high-performance propulsion and power generation, high-temperature processing facilities such as furnaces, material casting and extrusion facilities, toxic and hazardous waste disposal facilities, and high-performance brakes for aircraft and space craft.

REFERENCES:
Hypersonic Rocket Sled Development, AD-TR-82-41 Krupovage, Daniel J., Rasmussen, Hans J., September 1992

AF95-232 TITLE: Catalyst for Flooded Type Lead-Acid Batteries

CATEGORY: Basic Research
DOD TECHNOLOGIES: Electronics

OBJECTIVE: Improve and test a liquid catalyst to extend lead acid battery life.

DESCRIPTION: Battery technology is extremely important for Uninterruptible Power Supply (UPS) development and any application where energy must be stored and later delivered as electric energy. Currently, most flooded type lead-acid batteries used for UPS system last only 2-5 years and cost up to 40 percent of the total UPS costs. BAT Technology has developed a liquid catalyst which, when added to the battery electrolyte, will extend lead-acid battery life 2-4 times, eliminate most hydrogen gassing created during charging, and currently increases the battery's total capacity by one quarter. Further research is needed to possibly improve the performance of this catalyst in UPS flooded type batteries and investigate the application potential of the catalyst in other areas of technology. BAT hopes to improve the liquid catalyst as test results come in and will research the use of other catalysts for other types of batteries.

PHASE I: Identify battery catalysts/additives to improve battery properties, such as gassing, power generation and longevity. The chemistries of the catalysts/additives shall be evaluated and the effects of possible combinations. Testing of catalysts/additives to evaluate claims shall also be accomplished.

PHASE II: Expand the testing program to include various types of batteries used in power quality applications and combined use of catalysts/additives. Environmental chamber testing under a variety of load conditions will be accomplished, simulating worst case heat and humidity conditions.

COMMERCIAL POTENTIAL: Environmental issues surrounding battery shipment, storage and disposal contribute greatly to costs of UPS systems. Previous limitations in battery technology, specifically battery life have impeded the use of UPS given the costs associated with their replacement and environmental hazards. Validation of battery life extension and catalyst improvement present unlimited potential in commercial marketing of these products while potentially realizing substantial government savings.

AF95-233 TITLE: Superconducting Magnetic Energy Storage (SMES) System with Adaptable Voltage Level Output

CATEGORY: Engineering Development
DOD TECHNOLOGIES: Energy Storage

OBJECTIVE: Develop a power electronic module to connect a Superconducting Magnetic Energy Storage (SMES) magnet to dc voltage levels in the range of 500 to 5,000 Vdc.

DESCRIPTION: An SMES system typically consists of a superconducting coil assembly, some sort of power equipment to connect the dc environment of the coil to the ac environment of the AFB electrical power system. Other military or commercial uses of this energy storage device may require the connection of the coil to dc devices. A superconducting coil has no resistance to the flow of current, and therefore has no voltage at its terminals when the dc current is flowing through the coil. When discharging the coil, the voltage on the coil terminals is typically equal to the external voltage of the load it is connected to. By connecting the coil directly to this equipment with this voltage level, the voltage level on the coil during discharge is set, and thereby the maximum power output by the coil as given by P(power) = V(voltage)*I(current). If a higher power level is demanded to meet the load, or if a higher current than the magnet current is required by the load, some form of dc-to-dc conversion is required. Several such dc-to-dc conversion methods are known in the power electronic community.

PHASE I: Compare the variety of topologies with a wide range of output (load) conditions as to expected reliability (number of parts, stresses on components), ease of up-and-down-grading to different power levels (modularity), efficiency, physical size, weight, and production cost.

PHASE II: Demonstrate a prototype system connected to an existing motor drive or UPS inverter system, with a power rating up to 5MW.

COMMERCIAL POTENTIAL: The application of SMES system has the potential to replace batteries in many applications in the commercial and military sector. The proposed work will greatly enhance the flexibility of interconnecting SMES system to a variety of existing equipment, and may very well open additional applications such as welding and new pulsed power weapon systems.

AF95-234 TITLE: Micro-Superconducting Magnetic Energy Storage (SMES) System Scale-up for Substation Applications

CATEGORY: Basic Research
DOD TECHNOLOGIES: Energy Storage

OBJECTIVE: Develop technology for construction of micro-Superconducting Magnetic Energy Storage (SMES) magnets with energy and power ratings for substation sized loads (8-10 MJ, and 8-10MW).

DESCRIPTION: Micro-SMES systems have the potential for replacing battery energy storage systems in back up and power quality applications. Present systems have energy storage/delivery capacities of 3 MJ/750-1400 kVA. These systems can provide quality power to individual buildings or isolated loads. Larger systems could be attached to electrical sub-stations to provide quality power to all loads connected to the sub-station. Such systems require the development of superconducting energy storage magnets with energy storage capacities in the 8-10MJ range. These magnets must be capable of rapid discharge and recharge (1 second discharge/3 minute recharge) while being size compatible with installation near electrical sub-stations.

PHASE I: Develop conceptional designs based on experience with systems presently under evaluation. Studies will include magnet geometry and structure; conductor type and detailed design; structure type and materials: modularity, economics and ease of manufacturing and different construction techniques.

PHASE II: Construct a prototype magnet or sections thereof and demonstrate its operation when connected to an existing SMES power electronics system.

COMMERCIAL POTENTIAL: Larger micro-SMES system technology has wide commercial applicability for providing quality power to diverse industrial and commercial loads, as well as assist utilities in optimizing the use of distribution and transmission systems.

AF95-235 TITLE: Infrared Focal Plane Array Tester

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop an infrared focal plane array inspection unit that would qualify wafer dye cuts in the optical domain using contactless procedures.

DESCRIPTION: Focal plane arrays (FPAs) are the most critical component in infrared Imaging equipment, such as night vision, security and surveillance systems. FPAs (PtSi, HgCdTe, PbSe, Si:Ga/As/Sb, Ge:Au/Cd/Cu/Hg/Zn, InSb, etc.), are manufactured in essentially two distinct phases. The first phase produces the FPA chip/die and is based on processes similar to those used to manufacture microelectronic integrated circuits. The second phase involves marrying the FPA chip/die with other microelectronic components for array control and data readout. After this second phase, a complete, final FPA module assembly is formed. Unfortunately, at present, it is not until this final module is completed that functional testing can be performed. The overall outcome is one of increased investment in labor and material after each step in the process; and it is not presently possible to determine if the final product is successful until all steps and materials have been incorporated. Thus, since the entire manufacturing process can take up to 12 weeks to complete, much time and effort is spent on modules which may ultimately prove to be defective. Current defect rates are in the order of 80% and are attributed to defective FPA chips/die. As a consequence, the availability of fully functional FPA modules is limited; and the price of those produced is unacceptably high.

The purpose of this project is to intervene in the early stage of FPA chip/die manufacturing process by testing the chips/die before being assembled with the other, added-value support electronics. This project is to design and develop a special non-contact test probe unit which can be used to test the FPA chips/die after they have been microelectronically-produced and before being assembled with any other circuit components. As a result, only known good FPA chips will be passed on to further assembly and integration, reducing the final cost of good FPA modules.

PHASE I: Design and develop a contactless FPA wafer die test system.

PHASE II: Demonstrate a prototype system in the Electro-Optics Technology Center at McClellan AFB, CA.

COMMERCIAL POTENTIAL: The technology of optical signal injection and optical electronics measurement techniques for this project have application to commercial, state and local agency needs. The direct infrared sensor applications of fire fighting, security and personnel monitoring, chemical detection, environmental compliance sensing, and animal census control can benefit from the increased yields and technology available at lower costs.

AF95-236 TITLE: Composite Shelter Manufacturing

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Materials and Processes

OBJECTIVE: Develop an automated manufacturing procedure for fabrication of electronic system vans and shelters from graphite composite materials.

DESCRIPTION: The manufacturing technology for van and shelter construction has remained virtually unchanged for the last 30 years. The lack of development is not associated with failure of technology to advance but rather to the general acceptance

of aluminum panel construction throughout DoD and to the higher funding priority of weapon systems. Increased need for electro magnetic hardenability/TEMPEST and reductions in DoD budgets however is making a technology upgrade a necessity. Graphite composite molded panels and components offer advantages in virtually every need. Automated processing, void of manual lay-up of panels, is the prime objective. Structural members, electrical channeling, air ducting, etc would be formed in place. A control system will possess all capabilities to calculate manufacturing data necessary to form a panel capable of accepting pre-formed wire harnesses and electronic components without secondary operations. A computer modeling capability, coupled with construction by modular build-up, will allow for rapid and economical design, modification and remanufacturing/repair of vans and shelters. The vans and shelters will be developed to International Standard Organization (ISO) requirements.

PHASE I: Define mechanical and physical characteristics for ISO shelter construction. Select a proposed process for shelter manufacturing procedures.

PHASE II: Fabricate a prototype ISO shelter using the selected composite material and process.

COMMERCIAL POTENTIAL: The graphite composite shelter made to ISO requirements, offers a high strength, low weight item which can be utilized in a wide variety of ways ranging from containers for air or marine transport to shelters for use by exploration companies in remote corners of the world.

AF95-237 TITLE: High Speed Detector Technology for Fourier Transform Infrared (FTIR) Applications

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Laser, Optics & Power Systems

OBJECTIVE: Develop high speed Focal Plane Array (FPA) technology to obtain higher spatial resolution.

DESCRIPTION: The FTIR approach is considered the best design for spectral/spatial measurements. Current prototypes under development are limited to a 10x10 element detector array. The technical challenge requiring particular innovation, is to improve the resolution performance of the detector assembly by implementing a larger detector array matrix (minimum 12x12) while incorporating the following upgraded detector array characteristics: a. Column or discrete readout (no "rolling or sectorized readout"); b. Read out rate of 40-80 KHZ for each pixel; c. Optimum fill factor; d. Approximate total detector array size of 3 mm x 3 mm; e. Detector pitch of approximately 100 micrometer; f. D* of at least 4 x e10; g. Minimum 12 bit digitizing resolution; h. Detector, Multiplexer with dewar & ADC chain; i. Electronics produce usable digital signal with no processing.

PHASE I: Develop potential design concepts and conduct alternative design trade-off analysis. Recommend and specify optimum design.

PHASE II: Demonstrate the Phase I selected design and develop prototype hardware and associated electronics

COMMERCIAL POTENTIAL: Environmental Detection, Site Monitoring, Remote Sensing for manufacturing applications.

REFERENCES:
DST-1700H-380-90, IR and RSC Signatures of Aircraft and Air Launched Missiles-ECC

DD1497-Intelligence Production Requirement, "Optical Band Missile Signature Data", Requesting Agency Control #ASD-91-12

Target Signature Measurement and Database System (TSMADS), "Target Data Requirements and Data Support Capabilities"

AF95-238 TITLE: Infrared Continuous Wave Lasers

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Design and develop a high-power, infrared, Continuous Wave (CW) laser.

DESCRIPTION: There has been a large investment by the Air Force in developing laboratory simulation test and evaluation techniques. One testing method involves the use of a high power, continuous wave (CW) laser to present an infrared source to a unit under test. This effort will investigate and exploit the developments in laser technology, especially in the area of solid state lasers, in order to produce a laser system that the Air Force can utilize in support of its laboratory simulation testing efforts. Proposed laser system and supporting hardware should meet the following requirements:

- Wavelength operation anywhere within the 3.9 to 4.1 micron band or the 4.4 to 5.0 micron band.
- Minimum output power of 2 watts.

- Exhibit continuous wave operation.
- Better than 10% (peak-to-peak) power stability.
- Mode quality: TEMOO.
- Linear polarization.
- Water cooled.
- Beam size: Less than 5 millimeters.
- Beam divergence: Less than 5 milliradians.
- No usage or production of hazardous substances.

PHASE I: Develop preliminary system designs and perform trade-off analysis in order to select the most promising technology candidate that meets stated requirements. Laser system concepts should be of sufficient detail to allow for government review and selection. A laboratory demonstration of the selected candidate laser system will be performed. A final report detailing the results of this effort and follow-on work will be generated.

PHASE II: The development, fabrication and testing of the selected laser system covered in Phase I will be accomplished. Development efforts within this phase include hardware delivery, software development, and system support documentation. The system will be thoroughly evaluated and the results documented in a final report.

COMMERCIAL POTENTIAL: Innovative infrared, CW laser technology could be used to support civilian applications in the medical field for laser-base refractive surgery and in the earth sciences field for infrared spectroscopy.

REFERENCES:
"IR Scanning Camera Data for USN-UTRC Acrylic Tests at 3.8 Micron Radiation," AD-A62 100

AF95-239 TITLE: Synthesis Aperture Radar (SAR) Hardware-In-The-Loop (HITL) Simulation

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors

OBJECTIVE: Develop methods for hardware-in-the-loop simulation testing of guided weapon seekers with synthetic aperture radars.

DESCRIPTION: Guided weapons are becoming more sophisticated and as consequence more expensive to develop and field. The cost can be significantly reduced by including HITL simulations in the weapons development process. The goal of this project is to develop and implement HITL simulation testing techniques with SAR seekers. The capability to test these SAR seekers in a HITL laboratory environment will greatly reduce the cost of developing and flight testing weapons with SAR seekers. The technical challenge is to be able to use existing HITL simulators to test SAR seekers by developing innovative software techniques and by making modifications to the existing simulation hardware.

PHASE I: Define HITL simulation test requirements for SAR seekers, investigate candidate concepts for HITL simulation testing of SAR seekers, conduct analytical evaluations on each candidate concept, report the advantages and disadvantages of each concept, and recommend a concept to be pursued in Phase II.

PHASE II: Design and demonstrate performance of the selected Phase I concept by developing prototype hardware and software and performing "proof of principle" testing in a controlled environment; collect and analyze test data.

COMMERCIAL POTENTIAL: Use of synthetic Aperture Radar has strong commercial potential in many sensor applications. Specific examples include sensor use in: 1) commercial aircraft navigation and landing instrumental systems; 2) intelligent highway vehicle collision avoidance systems; and 3) environmental surveying and monitoring systems. SAR GITL simulation testing directly benefits these commercial applications by facilitating improved design and cost efficient development of the SAR sensors.

AF95-240 TITLE: Quick Look Capability for Warhead Arena Testing

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Electronic Devices

OBJECTIVE: Exploit new developments in computational ability to provide a rapid summary of complex test results.

DESCRIPTION: With the advent of computationally powerful work stations, the ability to quickly reduce data from complex tests has increased. However, this ability has not been applied to many standard test environments due to the actual or perceived difficulty in interfacing with the various data recording instruments. The data is collected and forwarded to mainframe computer

where the analysis is conducted. This results in a significant time delay before the results of the test are available for publication. The fundamental goal of this effort is to develop the capability for a rapid test data summary report to be provided at the test site at the conclusion of the test. The technical challenge is to determine necessary hardware and software interfaces between a workstation and various sensors, switches, etc., from which data is gathered; to assemble the data, analyze the data, display the data and print a summary report before the conclusion of the test mission.

PHASE I: Define and determine the necessary hardware and software interfaces required to accomplish the objective.

PHASE II: Develop the required hardware and software and demonstrate the prototype system during actual test events under benign test conditions.

COMMERCIAL POTENTIAL: High speed assembly, compilation and dissemination of large volumes of test data represents a significant technical challenge, with substantial commercial market potential. Specific industry examples, such as development testing of advanced Intelligent Vehicle Highway Systems or commercial aircraft components highlight specific industry needs for integration of work station computers with test sensors, test instrumentation and software. Virtually any industry that requires testing of complex developmental items, where multiple data streams must be collected/reduced/evaluated against a standard or theoretical value, would offer commercial market potential.

REFERENCES:

AD-TR-72-127 "Vulnerability and Lethality Testing System", December 1972, DTIC Accession No. AD 909 145L

AF95-241 TITLE: Munitions Systems Test and Evaluation Technologies

CATEGORY: Exploratory Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop innovative concepts and techniques for testing and evaluating munitions systems.

DESCRIPTION: New and innovative ideas/concepts/techniques are sought which apply to the test and evaluation of non-nuclear weapons and munitions systems. Interests include innovative approaches to: (1) open-air testing of air-launched weapons (such as unguided and precision-guided bombs, dispensers and submunitions, air-to-air and air-to-surface missiles, aircraft gun systems, etc.); (2) modeling, simulation, and analysis techniques which will provide accurate predictions of weapon system effectiveness and target damage assessment; (3) evaluation of the interaction between the test aircraft and the munitions being launched/dropped and techniques for accurately tracking the flight of the munition(s) during testing; (4) assessment of munition performance relative to countermeasures and counter-countermeasures; (5) reduction of test costs, reduction of test time, improvement of accuracy measurements and target damage assessment techniques, or improvement of test safety; (6) enhancement of capability for testing large footprint weapons; and (7) development of a large water range for over-the-horizon testing and low altitude instrumentation. Innovative research is sought to address the full range of munitions systems test and evaluation requirements (i.e., digital modeling and computer simulation, measurement facility testing, integration laboratory testing, hardware-in-the-loop testing, installed system testing, and open-air range testing).

PHASE I: Define innovative ideas/concepts/techniques with potential to improve the current approach to test and evaluation of munitions systems. Conduct analyses and make recommendations for development of concepts with greatest payoff potential.

PHASE II: Develop the selected Phase I concepts and techniques and demonstrate payoff.

COMMERCIAL POTENTIAL: The technologies associated with this topic focus on enhancement of sensors, measurement instrumentation, computer modeling and simulation, and integrated system testing. Each of these technologies have viable commercial application and market potential. Specific examples of industry needs for advancement in these technology areas include: advanced Intelligent Vehicle Highway Systems sensor testing, imaging sensors for environmental surveying and monitoring, and law enforcement monitoring and interdiction. These broad technology enhancements are sought to offer application for both military and commercial usage.

REFERENCES:

AFDTC Technical Facilities document(s) - TBD - pending removal of distribution restrictions

AF95-242 TITLE: Anechoic Chamber Computer Software Model Simulation

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Design and develop a computer software model to simulate and predict the Radio Frequency (RF) environment of anechoic chambers.

DESCRIPTION: This requirement is for the development of a Radio Frequency (RF) Environment Software Model of Anechoic Chambers. Currently, the test set-up time required to conduct anechoic chamber tests can range up to weeks. Various variables contribute to the lengthy test set-up time. Some of these are the System Under Test (SUT) size, the customized arrangement of Radar Absorbing Material (RAM), and the nature of the test. A computer software model to simulate the anechoic chamber Radio Frequency (RF) environment would expedite test set-up time. The computer model would do this by optimizing the arrangement of RAM and the position of the SUT. In addition, the computer model would predict the RF environment of the anechoic chamber. The simulation will predict power levels at various locations within the anechoic chamber, plus display the scattering and reflectivity levels of the transmitted wave. The simulation features of the computer model will optimize future planned tests on particular systems.

PHASE I: Conduct an analytic feasibility study. Type(s) of software, hardware, and system component design required to produce an accurate computer software model for simulation of anechoic chambers will be presented. Details defining candidate solutions and alternatives will be documented and delivered.

PHASE II: Prototype, develop, demonstrate, evaluate and deliver the anechoic chamber software simulation computer model. Anechoic chamber measurements shall be taken with a specific SUT in the Benefield Anechoic Chamber. The data will be recorded, retrieved and compared to the computer software model trial simulation run results to determine the level of accuracy and amount of error in the simulated data from the model. Complete documentation of test cases and results must be delivered. Full software source code and support documentation will also be delivered.

COMMERCIAL POTENTIAL: Accurate simulations produced by this computer software model may reduce the amount of testing, and increase the cost effectiveness of tests that require the use of anechoic chamber facilities. Availability of the model to the civilian sector currently operating anechoic chambers would be made possible.

AF95-243 TITLE: Large-Volume, High-Speed, Data-Management Technology

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Software

OBJECTIVE: Develop efficient high-volume, high-speed, data-management technology compatible with current technology data storage formats.

DESCRIPTION: This requirement is for the development of software technology to support an efficient, large-volume data-management system. Develop scientific data-management-system technology to handle large volumes of lengthy, continuous engineering time history data. This technology must accommodate virtually an unlimited number of parameters, data points, and data sets. Reasonable upper limits could approach 1,000 data sets, 10,000 parameters per set, and 10,000,000 data points per parameter. Data can be stored sequentially from the data acquisition without defining the number of data points for each parameter. Its internal data organization must be fully compatible with one of three popular, scientific, data-storage formats: the Common Data Format (CDF), the Network Common Data Format(NetCDF), and the Hierarchical Data Format (HDF).

PHASE I: Conduct a feasibility analysis and propose software design(s).

PHASE II: Construct a prototype software system and demonstrated the technology at Edwards AFB using large, flight-test, data files.

COMMERCIAL POTENTIAL: Large data-retrieval systems are limited by fast access to hierarchical data format. Innovative techniques for accessing these data bases will become increasingly important in the future for the public and commercial organizations as the availability on the large data files become more available.

AF95-244 TITLE: Innovative Infrared (IR) Scene Generation Using Defense Mapping Agency (DMA) Database

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Improve capability to generate realistic IR scenes using terrain features from DMA databases and related earth mapping technology.

DESCRIPTION: Infrared sensor testing and evaluation is partially limited by the realism of the scene content due to a lack of IR specific terrain database. A methodology is needed to overlay polygon grids with thermal/optical properties on top of

high-resolution terrain databases. The methodology must address (1) large database storage/handling, (2) impact of DMA data limitations (Levels 1-3C), including thermal loading, thermal transport, emissivity, bireflectance, etc., and (3) IR scene generation validation. Airborne weapon system applications include (1) Missile Launch Detection (MLD), (2) Forward Looking Infrared (FLIR) sensors used in airborne navigation and air-to-ground targeting, and (3) Infrared Search and Track (IRST) sensors used to locate airborne targets on the horizon. This effort will analyze alternatives, propose innovative remedies to current limitations, develop an IR scene generation methodology (using DMA terrain databases), and develop an implementation plan for a working prototype.

PHASE I: Should result in a technical feasibility analysis and proposed system design.

PHASE II: Will result in a demonstration of a prototype system in the Benefield Anechoic Chamber at Edwards AFB CA.

COMMERCIAL POTENTIAL: This technology is directly applicable to analysis and interpretation of infrared earth monitoring satellite data. Applications include climate change predictions, agricultural forecasting, forest deviation analysis, natural disaster monitoring and emergency management data analysis. As FLIRs become more and more utilized by commercial aviation, then pilot training using these systems will increase. This is an essential element for full fidelity training by the commercial aircraft and airline industry.

AF95-245 TITLE: Optical Coupler Between Infrared (IR) Scene Emitter and Installed Sensors

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Design and develop a method to use IR scene emitters to optically stimulate the IR sensors.

DESCRIPTION: IR scene emitters have matured during the past decade to the point where they are potentially useful for stimulating the IR sensors of equipment installed on aircraft. (for example: forward looking infrared radar (FLIR), IR search and track systems, and missile launch detection systems). However, the optical coupling of the scene emitter to the installed sensor and the integration of this coupling system is a technological challenge. Direct attachment of equipment to the aircraft or free-field coupling are alternatives. However, during testing the test aircraft is statically suspended. Once the aircraft is thus suspended, direct and stable access to it is difficult. The sensor aperture sizes are limited to less than 8", fields-of-view are up to 120 degrees, and stability is in the .5 milliradian range. Scene emitters are 1024x1024 element.

PHASE I: Perform a technical feasibility analysis and propose a system design.

PHASE II: Demonstrate a prototype system in the Benefield Anechoic Chamber at Edwards AFB, CA.

COMMERCIAL POTENTIAL: The optical coupling system is directly applicable to the test, alignment and stabilization of IR sensing equipment using IR scene emitters, for example vacuum welding, medical surgery, and hazardous materials processing equipment. The commercial aircraft market and Federal Aviation Administration (FAA) are forecasting the use of Forward Looking Infrared (FLIR) Systems which will have to be developed, tested and evaluated. These systems will have to be maintained and periodically certified to FAA standards. The capability would substantially reduce the labor and time for this certification.

AF95-246 TITLE: Non-Electromagnetic Interfering (EMI) Signal Injection Technology

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Design and develop a technique for test signal injection that does not produce electromagnetic interference (EMI), or use hardwire or fiber optic linkages.

DESCRIPTION: Testing of integrated avionics equipment installed on aircraft requires injecting data without producing EMI, and without direct connection between the data source and the system under test. Data may be digital or analog and data capacity is very high. Optical links for telemetry is the preferred technology; however capacity and reliability are critical issues.

PHASE I: Perform a technical feasibility analysis and propose a system design.

PHASE II: Demonstrate a prototype system in the Benefield Anechoic Chamber at Edwards AFB CA.

COMMERCIAL POTENTIAL: Applicable to inter-satellite communications, remote control of robots, safe arm and fuse of explosives, and EMI testing facilities. This capability could be used in the commercial market to download aircraft information to maintenance organizations without the necessity to "hook-up" to the aircraft. This would save maintenance time.

AF95-247 TITLE: Radar-Transparent Self-Stabilizing Support for Infrared Sensor Stimulator Head

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Sensors and Electronic Combat

OBJECTIVE: Develop an articulated support arm for an infrared sensor stimulator head with a low radar cross section.

DESCRIPTION: This requirement is for the development of low radar cross section articulated arm. A support system for an infrared sensor stimulator head is required, such that the stimulator is fixed in space with respect to the sensor under test, but not in physical contact with it. The sensor is part of an integrated sensor suite installed on an aircraft undergoing multi-band testing. The support system should present minimal radar cross section. The stimulator head is expected to weigh about fifty pounds. Stability requirements shall equal those for broadcast television cameras.

PHASE I: Should result in a technical feasibility analysis and proposed system design.

PHASE II: Will result in a demonstration of a prototype system in the Benefield Anechoic Chamber at Edwards AFB, CA.

COMMERCIAL POTENTIAL: The technology to manufacture this equipment could be applied to reduced size composite beams (by substitution of active for passive damping and stiffness) for structures, such as lift buckets, requiring vibration control, low mass, controlled center of gravity, and corrosion resistance. This technology could provide a non-interference method to evaluate and check either aircraft or ground-based radar systems. The reflections from this mechanism would be substantially reduced.

AF95-248 TITLE: Green Masking for Microcircuit Lithography

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Environmental Effects

OBJECTIVE: Develop an environmentally friendly, near-zero-waste-stream, integrated-circuit, masking technology.

DESCRIPTION: Currently, Integrated Circuits (ICs) are manufactured via a multi-step process which includes the photographic definition of patterns on glass plates (masks) which are used to impart these patterns onto the surface of individual silicon wafers. The glass masks are coated, via evaporation, with a thin layer of chrome which is subsequently etched away to leave a pattern of chrome-and chromeless areas. This results in a pattern of opaque and transparent areas and either blocks or passes ultraviolet light to the surface of the IC wafer which has been coated with a photosensitive chemical. The new approach would provide an environmentally clean masking process to be fielded throughout the IC industry. The chemical materials presently utilized include chrome, photoresist polymer, acid oxidizer chrome etchant (Perchloric Acid and Ceric Ammonium Nitrate), photoresist developer (Potassium Hydroxide), sulfuric acid, hydrogen peroxide, deionized water and wafer cleaners (Hydrochloric Acid and Ferrous Chloride). The processing of each mask plate generates approximately one liter of waste. Most processes utilize at least ten masks each of which has a useful life of about 100 wafers. Thus, a typical facility which produces 10,000 wafers per month could be expected to reduce its present waste stream from 1,000 liters to near-zero--in addition to eliminating the cost of the original processing chemicals.

PHASE I: Study new technology approaches to eliminate the chrome-coated masks and the associated metal-etching chemicals and resulting heavy-metal waste stream, the photo sensitive chemicals and its associated photo developing chemicals, solvents and cleaning materials.

PHASE II: Transition the masking technology to organic fabrication and commercial manufacturing and production.

COMMERCIAL POTENTIAL: This technology impacts all of the US microelectronics industry which utilize photo lithography technology to manufacture integrated circuits. The waste streams of each of these manufacturers would be greatly reduced, as would the organic manufacturing waste stream. Adoption of this technology would reduce water usage, reduce waste volume, and eliminate waste containing antimony, silver, chrome, thallium, molybdenum and other metal elements. Additionally, the US currently obtains 99% of lithographic glass plates from Japan. The proposed new method eliminates this dependency on foreign suppliers.

AF95-249 TITLE: Dual-Use Neutron Beam

CATEGORY: Advanced Development
DOD TECHNOLOGIES: Materials

OBJECTIVE: Provide a neutron beam that will allow a rapid method of nondestructively inspecting metal engine blades for low hydrogen embrittlement and of sufficient intensity to perform neutron capture therapy.

DESCRIPTION: It is well known that titanium metals subjected to high temperatures and stress are susceptible to hydrogen embrittlement. By using a high intensity beam of neutrons and tomographic imaging techniques, it is possible to detect the presence of low level hydrogen concentrations (i.e., 100-200 ppm). This capability would result in a system that can, in a production mode, provide the information needed for acceptance or rejection of the engine blades. In addition, the same neutron beam properly designed can be used for neutron capture therapy.

PHASE I: Develop the design concept to accomplish the stated objective.

PHASE II: Demonstrate and validate that the system designed in Phase I meets the goals stated in the objective and description.

COMMERCIAL POTENTIAL: The problem of hydrogen embrittlement in jet engine blades is not limited to the military jet aircraft. The commercial airlines have the same problem. The neutron capture therapy aspects of the neutron beam will provide the medical community, both military and private, with a treatment capability that does not exist today.

DEFENSE NUCLEAR AGENCY

The Defense Nuclear Agency is seeking small businesses with a strong research and development capability and experience in nuclear weapon effects, phenomenology, operations and counterproliferation. (Note we are not interested in nuclear weapon design or manufacture.) DNA invites small businesses to send proposals to the following address:

Defense Nuclear Agency
ATTN: AM/SBIR
6801 Telegraph Road
Alexandria, VA 22310-3398

The proposals will be processed and distributed to the appropriate technical offices for evaluation. Questions concerning the administration of the SBIR program and proposal preparation should be directed to:

Defense Nuclear Agency
ATTN: Mr. Bill Burks/SBIR Program Manager
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-5021

DNA has identified 20 technical topics numbered DNA95-01 through DNA95-20. These are the only topics for which proposals will be accepted. The current topics and topic descriptions are included below. These topics were initiated by the DNA technical offices which manage the research and development in these areas. Several of the topics are intentionally broad to ensure any innovative idea which fits within DNA's mission may be submitted. Proposals do not need to cover all aspects of these broad topics. Questions concerning the topics should be submitted to:

Defense Nuclear Agency
ATTN: TAIC, Mr. James M. Gerding
6801 Telegraph Road
Alexandria, VA 22310-3398
Tel: (703) 325-1217

DNA selects proposals for funding based on the technical merit, criticality of the research, and the evaluation criteria contained in this solicitation document. As funding is limited, DNA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and filling the most critical requirements. As a result, DNA may fund more than one proposal under a specific topic or it may fund no proposals in a topic area. Proposals which cover more than one DNA topic should only be submitted once.

DNA has not set aside funds for bridge funding. As such, proposers should not rely on bridge funding to cover the time gap between Phase I and Phase II.

DEFENSE NUCLEAR AGENCY
FY1995 SBIR TOPIC INDEX

Subject Index for the DNA SBIR Solicitation

DEFENSE NUCLEAR AGENCY

FY1995 TOPIC DESCRIPTIONS

DNA95-01 TITLE: Nuclear Weapon Effects Phenomenology

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative algorithms to improve our understanding of nuclear weapon effects and the implementation of these algorithms.

DESCRIPTION: Accurate, efficient, user-friendly methods of calculating nuclear weapon effects and display/presentation of such calculations are required to improve the understanding of the phenomenologies involved. Areas of interest include more accurate calculations; relying on basic physical principles vice measured test results; faster running calculations; and new and improved ways to enable users (be they advanced nuclear weapons effects researchers, weapon systems developers, or managers with limited nuclear weapons effects experience) to calculate, estimate, and appreciate nuclear weapon effects. Nuclear weapon effects include airblast; ground shock; water shock; cratering; thermal radiation; neutron, gamma and x-ray radiation; electromagnetic pulse; fallout; blueout; blackout; redout; and dust cloud formation.

Improved methods are required for the management of technical information that relates to the archival of nuclear weapon phenomenology and test data, as well as input to and retrieval of such data archives. Methods for developing unifying test data standards devised with application beyond just nuclear test effects are needed to improve data processing efficiency and reduce hardware and software specific requirements.

During Phase I, the research will demonstrate the feasibility of the proposed approach improve the understanding of nuclear weapon effects or the archival and ease of use of stored data.

During Phase II, the research concepts developed in Phase I will be further developed and incorporated into appropriate codes.

COMMERCIAL POTENTIAL: Computer codes related to earthquake effects, pollution transport, signal propagation, data archival, and test standards for data.

DNA95-02 TITLE: Response of Materials and Structures to Nuclear and Conventional Weapon Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the survivability of weapon systems by using innovative materials and structure designs

DESCRIPTION: Of interest to DNA is understanding the response of materials, structures, and systems to nuclear weapons effects. Materials of interest include metals, ceramics and composites. New materials capable of being used as a structural members for aircraft, missiles, ships, submarines and military vehicles are of particular concern. New materials with enhanced electromagnetic shielding properties are also of interest.

Improved understanding of the failure mechanisms of structures is required. Type of structures include deep underground, land-based (fixed and mobile), sea-based (floating and submerged) and aerospace structures. Conventional as well as nuclear weapons effects are of interest. Improved methods are needed for analysis and model testing of structures to large deflection and collapse damage levels. Structures of interest include deep underground, land-based, sea-based, and aerospace structures.

During Phase I, the research will demonstrate the feasibility of the proposed designs/methodology to determine material or structural response to nuclear weapon effects.

During Phase II, the research concept developed in Phase I will be further developed where, if appropriate, the concepts will be incorporated into other existing methodology, codes, or structural designs.

COMMERCIAL POTENTIAL: Earthquake resistant buildings and material and design improvements for structures, ships, aircraft, and vehicles.

DNA95-03 TITLE: Nuclear Weapon Effects on Electronics

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Explore the effects of nuclear weapon explosions on electronics.

DESCRIPTION: The nature and magnitude of the effects produced by the interaction of nuclear weapon produced radiation on electronics, electronic systems, opto-electrical devices, and sensors in the phenomenology areas of: a) Transient Radiation Effects on Electronics (TREE); b) Electromagnetic Pulse (EMP); c) System Generated EMP (SGEMP); and d) Source Region EMP (SREMP) are of interest to DNA. Particular areas of concern include; methods by which designers of space, strategic and tactical systems can assess their susceptibility to these effects; technologies to reduce the susceptibilities of electronic systems and devices (especially those with submicron feature sizes) to acceptable levels; and methods to demonstrate survivability under specified threat criteria. Concepts and techniques to improve the survivability (decrease the response) of systems against these nuclear weapons effects are required.

During Phase I, initial feasibility studies will be completed to demonstrate the viability of the proposed approach.

During Phase II, continue the investigation which was begun in Phase I to fully develop and demonstrate the proposed approach.

COMMERCIAL POTENTIAL: Commercial satellites and electromagnetic interference/compatibility.

DNA95-04 TITLE: Nuclear Weapon Effects on Communication & Signal Propagation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the effects of nuclear weapon explosion on electromagnetic and optics/signals and the subsequent performance of communication and sensor systems.

DESCRIPTION: The Defense Nuclear Agency is interested in the basic physical processes which describe the interaction of nuclear weapons with the atmosphere, which create environments that degrade the propagation of communication and radar signals and that contain optical clutter backgrounds which degrade optical sensor systems. Part of DNA's mission is to predict effects on and determine mitigation methods for DoD systems such as satellite communications, VLF/LF communications, HF/VHF communications, radar systems, and optical sensor systems. Areas of interest include mechanisms for the coupling of nuclear weapon energy to the atmosphere; the development of structure in weapon produced plasmas and molecular emitters; the chemical processes which give rise to the optical emissions; the transport and final deposition of nuclear debris; the effects of degraded signal propagation on the performance of communication systems and radars; and the prediction of the effects of optical clutter backgrounds on the performance of optical sensor systems. Areas of interest also include the development of improved communications and sensor methods to mitigate atmospheric effects on systems and the development and application of simulators to test DoD systems to atmospheric effects.

During Phase I, demonstrate the feasibility of the proposed investigation to advance the understanding in any of the areas described above.

During Phase II, continue the investigation to the development of a product or results that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Commercial communication systems, sunspot effects.

DNA95-05 TITLE: Nuclear Hardening and Survivability

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative technologies to improve the nuclear hardening and survivability of DOD systems.

DESCRIPTION: Improved techniques for nuclear hardening and survivability of weapon systems, against nuclear weapons effects are required. These techniques should protect the system against the effects of blast, thermal, nuclear radiation, and electromagnetic pulse. In particular, the ability to harden communications facilities and surveillance sensors against electromagnetic pulse is of interest. Systems include planned and operational, strategic and tactical, ground mobile, missile, aircraft, and space systems and their subsystems and components.

During Phase I, demonstrate the feasibility and usefulness of the proposed technique.

During Phase II, fully develop the proposed technique and characterize its usefulness in both technical and cost terms.

COMMERCIAL POTENTIAL: Improved buildings, electronics, aircraft, satellites and better electromagnetic shielding.

DNA95-06 TITLE: Radiation Hardening of Microelectronics

CATEGORY: Exploratory Development, Electronic Devices

OBJECTIVE: Develop and demonstrate technology to: (1) radiation harden; (2) improve reliability and electrical performance; (3) improve radiation hardness and reliability assurance methods; and (4) characterize the radiation and reliability response of semiconductor devices (microelectronics and optoelectronics) including warm and cold operation metal oxide semiconductor (MOS), bipolar, and compound material technologies.

DESCRIPTION: The trend in semiconductor integrated circuits and sensors is toward increasingly higher levels of integration density, higher speeds, higher on-chip circuit complexity, lower voltage and power, and larger die size. All of these trends have exacerbated the problems associated with radiation hardening reliability, and testability. In addition, improvements in material science have lead to the introduction of a wide variety of compound semiconductor materials into microelectronic and opto-electronic applications. The radiation and reliability responses of these materials is lacking or unknown.

Thus, it is the objective of this topic to develop and demonstrate innovative technology and methods to: (1) ensure that these devices can operate in a radiation or other stressing environment (e.g. very high or low temperatures); (2) improve device reliability; (3) improve producibility and yield; (4) develop cost-effective hardness and reliability assurance methods; (5) investigate and characterize the radiation response and reliability performance of these devices and associated materials; and (6) maintain device performance without degrading robustness. The development of technologies which enhance reliability, producibility, and yield will support the commercial semiconductor sector. In addition, the development of methods to improve the survivability of microelectronics in severe stressing environments is directly related to the commercial semiconductor and electronics industries.

During Phase I, the research will demonstrate the feasibility of the proposed technology and methods concepts.

During Phase II, the research concepts developed in Phase I will be demonstrated or reduced to engineering practice.

COMMERCIAL POTENTIAL: Microelectronics, Satellites

DNA95-07 TITLE: Nuclear Weapon Effects Simulation Technology

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the state-of-the-art in nuclear weapon effects simulation technologies.

DESCRIPTION: Simulators are needed to: provide experimental data for development of numerical simulations of nuclear weapons effects; simulate one or more nuclear weapons effects at laboratory size scale; and improve weapon system test capability. Simulation requirements include airblast over various surface conditions, dusty flow, dust lofting, shock propagation in rock, water shock, thermal radiation, EMP, and nuclear radiation.

Existing large scale simulators are often expensive and time consuming to operate, and require travel to an explosive test site. Small scale simulators are needed to provide extensive data to supplement the limited amount of data available from the large scale simulators. Innovative simulators are needed which are economical and simple to operate. Innovative ideas are needed on how to use very small scale simulators to produce useful information.

During Phase I, demonstrate the basic simulator concept.

During Phase II, demonstrate a laboratory scale simulator and produce useful data.

COMMERCIAL POTENTIAL: Numerical analysis; metrology; earthquake, hurricane, and tornado survivability.

DNA95-08 TITLE: Instrumentation

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Advance the state-of-the-art in nuclear and conventional weapon effects instrumentation.

DESCRIPTION: Instrumentation is used for measuring nuclear and conventional weapon effects, phenomenology parameters, the response of test items exposed to conventional or simulated nuclear weapon effects. The instrumentation should be capable of operating under very harsh conditions, such as might be encountered in blast and shock tests, or tests involving high levels of x-ray, gamma, or neutron radiation. Instrumentation is needed for the following types of tests: airblast, ground shock, dusty flow, dust lofting, water shock, shock propagation in rock, High Explosive (HE), nuclear radiation (x-rays and gamma rays), thermal radiation, electromagnetic pulse (EMP) (high altitude or systems generated), and for improved data acquisition

(transmission and recording). Desirable improvements include costs, ease of use, precision, accuracy, reliability, ease of calibration (preferably on site) and maintainability.

During Phase I, build a prototype instrument or instrument system and demonstrate its performance in laboratory scale testing.

During Phase II; design, build, and test a full scale instrument system demonstrating its performance in its intended working environment. This may involve coordination with DNA to schedule testing in a simulator.

COMMERCIAL POTENTIAL: Metrology, Blasting Operations, Earthquake studies, radiation testing/monitoring, large structure (e.g., buildings, dams, and mines) integrity, fire protection, lightning protection, hazardous waste containment.

DNA95-09 TITLE: X-Ray Effect Simulation Technology

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative technologies for the production of x-ray radiation.

DESCRIPTION: (a) Future requirements for x-ray nuclear weapon effects testing will require vast improvements in existing radiation source capability as well as new concepts for producing soft x-rays (1-5 kev), warm x-rays (5-15 kev), and hot x-rays (>15 kev). Soft x-rays are used for optical and optical coatings effects testing. Warm x-rays are used for thermomechanical and thermostructural response testing; and hot x-rays are used for electronics effects testing. The proposer should be familiar with the present capability to produce x-rays for weapon effects testing.

(b) Present Plasma Radiation Source (PRS) x-ray sources generate copious amounts of debris (material, atomic charged particles, sub-KeV photons). Debris production is an even greater concern for the simulators currently under development. New measurements and analysis technologies are required to characterize the source and the debris generated from wire array and z-pinch PRS sources to better understand debris sources and mitigation. Existing debris shield technologies are not adequate to support larger exposure areas and cleaner test environments while minimizing fluence degradation. New methods, or combination of methods, need to be developed to stop, mitigate, and/or delay debris generated for DECADE class radiation simulators.

(c) New technologies to measure plasma parameters for simulator sub-systems such as plasma opening switches and plasma sources used in are of interest. Test response diagnostic technologies are required to measure the full time and spectral history of the radiation pulse across the breadth and width of the test asset as well as the response of the test asset during and after irradiation. Pulsed power diagnostic technologies are required for accurate, in-situ measurement of voltages and currents within the various simulator subsystems in order to monitor and characterize simulator performance. Diagnostic systems include required sensors/detectors, cabling, recording equipment and media, and, if necessary, computer systems and software.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test, and evaluate proof-of-principle hardware in its working environment on an AGT radiation simulator. This will involve coordination with DNA to schedule testing in a aboveground test simulator.

COMMERCIAL POTENTIAL: Nuclear instrumentation, very fast closing valves.

DNA95-10 TITLE: Standard Set of Objects for Radio Frequency (RF) Testing

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop technologies required for a standardize, generic set of objects to facilitate RF upset/damage concept assessment.

DESCRIPTION: Develop technologies leading toward a standardized generic set of electronics for standardized RF test comparison. This set of unclassified objects will be used to compare source and effects testing results. Currently most tests are one of a kind because they are accomplished with one of a kind objects. This test technology would provide a low cost method for initial assessment while being comparable with other tests.

During Phase I, initial feasibility studies will be conducted to demonstrate the technology.

During Phase II, a test set based on the new technologies developed will be subjected to rigorous examination and testing to ensure the necessary inherent qualities are present to support generic RF testing.

COMMERCIAL POTENTIAL: Electromagnetic Interference/compatibility testing.

DNA95-11 TITLE: Nuclear Forces Security and Survivability Technologies

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improved security and survivability of US nuclear forces.

DESCRIPTION: The possible possession of weapons of mass destruction (WMD) is of vital concern to prelaunch survivability (PLS) of nuclear forces. New and innovative concepts to improve PLS are needed to retain a viable nuclear strike capability and to enhance deterrence. The threats include enemy forces conducting unconventional, conventional, chemical and nuclear warfare during periods of peacetime, transition to war, and war. Long range program thrusts include peacetime and field storage, deceptive/OPSEC practices, nuclear force movements, and operational survivability of nuclear systems (aircraft and missiles). Concepts should employ innovative ideas and make use of new and emerging technologies. Work will include detector technology improvements and advanced algorithms for improved signal to noise ratio.

Measures to improve the security of nuclear weapons against all possible threats are required. Security measures include detection, assessment, and denial systems. Proposals should describe how they will improve protection against known and predicted threats and should emphasize weapon concealment where appropriate.

During Phase I, demonstrate the feasibility and potential usefulness of the proposed security or survivability technologies.

During Phase II, fully develop the proposed technologies so they can be compared to existing techniques.

COMMERCIAL POTENTIAL: Commercial Security Systems

DNA95-12 TITLE: Operational Planning and Targeting Technology

CATEGORY: Exploratory Development, Communications Networking

OBJECTIVE: Improved ability of US nuclear commanders to plan for nuclear engagements and target nuclear weapons.

DESCRIPTION: The nuclear employment planning capabilities of operational commanders in tactical, strategic and integrated warfare environments require improvement. These improvements include development of automated planning systems; technologies to determine target damage objective and criteria; post strike target damage assessment capabilities; and automated nuclear weapon employment codes. Techniques to account for electromagnetic effects in operational planning and exercises are also desired.

During Phase I, develop the proposed technology in sufficient detail to demonstrate its feasibility.

During Phase II, continue the development of the proposed technology to the point it can be incorporated into existing planning/targeting methodologies.

COMMERCIAL POTENTIAL: Logistics planning, shipping route planning.

DNA95-13 TITLE: Verification Technology Development

CATEGORY: Advanced Development, Sensors

OBJECTIVE: Improve/develop US technical capability to verify/monitor compliance with existing and potential future arms control treaties and agreements, e.g., START, INF, CW, CFE, NTT, SNF, and Presidential Initiatives.

DESCRIPTION: New arms control measures are being negotiated which could drastically alter existing inventories of nuclear weapons. New verification technologies and methods will be required to accurately monitor compliance to the provisions of any treaties or agreements that could result from the on-going negotiations. The problem will basically involve being able to distinguish between permitted activities and prohibited activities where the technical signatures between the two could be very minor.

During Phase I, demonstrate the feasibility of the proposed technology in relation to a specific arms control application. During Phase II, develop a proof of design to demonstrate the proposed technology.

COMMERCIAL POTENTIAL: Inventory Systems, Chemical Monitoring Systems

DNA95-14 TITLE: Counterproliferation Technology

CATEGORY: Exploratory Development, Sensors

OBJECTIVE: Develop new technologies for countering the proliferation of weapons of mass destruction.

DESCRIPTION: In support of the Department of Defense counterproliferation initiative, the Defense Nuclear Agency (DNA) is interested in identifying and integrating proven and maturing technologies to develop and demonstrate an operational capability to counter the proliferation of weapons of mass destruction (WMD) located in hardened facilities. Specifically, DNA is interested in initiatives in the following technical areas:

Hardened Target Defeat. Develop physical/functional lethality criteria for the full spectrum of conventional and nuclear weapons, including precision guided munitions, and advanced non-nuclear weapon payloads. Of particular interest are the development of shaft and portal vulnerability models. The models will be validated via weapon testing against simulated hardened WMD targets.

Proliferation Path Analysis. Develop analytical models to predict the activities needed for development of WMD by additional nations. The model will alert DoD to potential proliferation activities and identify vulnerable chokepoints in the proliferation process for possible exploitation.

Enhanced Conventional Weapons Payloads Concepts. Develop concepts for the use of non-nuclear payloads delivered by penetrating weapons and released inside large, hardened WMD research/production/storage facilities to provide a significant increase in effectiveness (i.e. functional kill) over current conventional high explosive warheads. Of particular interest are payload concepts that limit the production of blast and high pressure gases, thus reducing collateral damage or nuclear/biological/chemical agent dispersal.

Collateral Effects Prediction Technology. Develop technology to define and predict weapon and target environments that cause unintended casualties. Of particular interest are improved atmospheric transport and dispersal models to provide significantly improved meteorological predictions along with embedded source term and transport models. The effort will also provide validated models to rapidly assess the effects of a strike on a WMD facility. End product will be a deployable collateral effects assessment capability for planners, decision makers, and users.

Targeting Technical Assistance. Develop technology to assist the theater user in conducting pre-attack weaponeering (including collateral effects prediction/mitigation) and post-attack battle damage assessment. Areas of emphasis include development of tools for proliferation path analysis, target planning, and collateral effects prediction/mitigation. End product will be a deployable expert system for operational planners using analytic prediction tools, multimedia hypertext databases, and technical manuals in concert with applied research, with possible sensor data use for condition updates.

Target Signature Evaluation. Develop sensor technology and analytical procedures for WMD target pre-attack characterization by understanding the operational aspects of target facility missions, architecture, prime mission equipment, critical subsystems, and functional vulnerabilities. The sensors must also provide data on weapon performance and reliable battle damage assessment. Of particular interest are air-dropped or man-emplaced unattended ground sensors, including hyper-spectral, seismic, thermal, electromagnetic, acoustic, gravimetric, and chemical.

Agent Neutralization. Provide a basic understanding of how chemical and biological weapons respond to weapons environments. Specifically, provide data and models describing the neutralization of threat agents to thermal, shock, and ionizing radiation environments. In addition, define the collateral effects source terms (quantity of agent released in viable form) of downed hostile cruise missiles carrying biological agent payloads.

During Phase I, DNA will continue its basic research to complete the development of codes and analytical models for weather, collateral effects, target/weapon interaction. Planning will begin on a Counterproliferation Advanced Concept Technology Demonstration (ACTD), which is planned for FY97.

During Phase II, DNA will identify promising technologies to be used in the Counterproliferation ACTD.

During Phase III, the end-to-end Counterproliferation ACTD will be conducted. The ACTD will feature pre-attack site characterization using sensors and analytic tools. High-fidelity targets (simulating hardened WMD targets) will be attacked using a variety of advanced conventional payloads to evaluate penetration, lethality, and collateral effects. Sensors will also be used to determine weapon performance and battle damage assessment.

COMMERCIAL POTENTIAL: Non-intrusive inspection of sealed containers (customs, antiterrorism, and environmental enforcement applications), traffic measurement, industrial activity measurement, facility security, and immigration control.

DNA95-15 TITLE: Pulsed Power Technology

CATEGORY: Exploratory Development, Energy Storage

OBJECTIVE: Dramatic improvements in energy storage, switching, and power conditioning technologies.

DESCRIPTION: Future requirements for systems employing pulsed power will necessitate improvements in efficiency, energy density, reliability, repeatability and overall performance over the existing state-of-the-art. Innovative approaches for component or subsystem development are sought to meet future demands for radiation simulators and other pulsed power applications. Examples include more efficient pulse forming technologies, high energy density capacitors, more efficient insulators, improved and more reliable switching technologies, and improved power flow electrical circuit models. Pulsed power applications include operation at kilovolts to megavolts, kiloamperes to megaamperes, and repetition rates from single pulse to 10 kilohertz.

Recent advances in energy storage and switching technologies now make possible the application of DNA pulsed power technology to such areas as armor/anti-armor; electromagnetic/electrothermal guns; mine-countermine; air, surface, and subsurface systems; high power microwave weapons; etc. Concepts for new applications of pulsed power should be highly innovative and make full use of the emerging pulse power technology.

During Phase I, demonstrate the feasibility of the proposed concept.

During Phase II, develop, test,and evaluate proof-of-principle hardware.

COMMERCIAL POTENTIAL: Power devices to clean up smoke stack effluents and environmental pollution control, metal cutting.

DNA95-16 TITLE: Directed Energy Effects

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Investigate the effects of directed energy and develop survivability technologies to mitigate these effects.

DESCRIPTION: The effects of directed energy sources such as lasers, neutral particle beams, charged particle beams, and radiofrequency weapons on materials, structures and systems are of interest to DNA. Of particular interest are the establishment of the correlation between nuclear weapon effects and directed energy effects, the identification of materials which are capable of withstanding both nuclear weapons effects and directed energy effects, and the interaction mechanisms of directed energy sources actually interact with target materials/structures.

During Phase I, demonstrate the feasibility of the proposed investigation.

During Phase II, characterize the effects of directed energy on materials, structures, etc.

COMMERCIAL POTENTIAL: High energy welding.

DNA95-17 TITLE: Forecasting Environments in the Troposphere and Space (FORETS)

CATEGORY: Exploratory Development, Environment Effects

OBJECTIVE: To investigate the effects of the natural and disturbed environments on atmospheric and space forecasting methods. Develop techniques to mitigate these effects, account for physical processes contributing to chaotic environments, and improve performance predictions.

DESCRIPTION: The Defense Nuclear Agency (DNA) is interested in the basic physical process which describes the effects of the natural and disturbed environment on the employment of various weapon systems. These environments may create situations that degrade the propagation of communication and radar signals, optical sensor systems, and weapon system employment. Part of DNA's mission is to predict effects the environment will have on these systems. Areas of interest include development of models and model predictions to forecast the effects of clouds on the theater of operations; the identification and streamlining of a model for support of theater operation; the development of a coupled space weather model to predict particle fluences and spectra; and the development of cloud and scintillation climatologies.

During Phase I, demonstrate the feasibility of the proposed areas of investigation to advance the understanding in any one of the areas.

During Phase II, continue the investigation leading to the development of models/products that can be incorporated into the existing technology base.

COMMERCIAL POTENTIAL: Weather prediction.

DNA95-18 TITLE: Advanced Lethality Technologies

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Demonstrate innovative applications of advanced non-nuclear technologies for enhanced target lethality or nuclear effects simulations.

DESCRIPTION: Of interest to DNA is the development and demonstration of capabilities which may significantly extend weapons range-to-effect or enhance lethality against hard targets. The response of a hardened bunker complex or of intrinsically hard ballistic missile sub-munition warhead payloads are of particular interest. Novel applications of explosives technology, hyperkinetic technologies, or directed energy (DE) concepts will be of interest.

During Phase I the research will develop concept feasibility through either analysis or laboratory scale demonstration.

During Phase II, the concepts will be further developed through more definitive experiments and/or sophisticated computational analyses.

COMMERCIAL POTENTIAL: Hypervelocity, advanced explosives.

DNA95-19 TITLE: Field Expedient Hardening

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Develop innovative methods that would temporarily harden military and civilian equipment to nuclear weapon effects.

DESCRIPTION: Innovative methods to temporarily harden military and essential civilian equipment to the effects of nuclear weapons are of interest. Installation should be relatively easy and quick (hours to a few days) and provide protection for several months to a year. Such hardening methods must be practical for field equipment and allow operation of the system.

During Phase I the research will develop concept feasibility through either analysis or laboratory scale demonstration.

During Phase II, the concepts will be further developed through more definitive experiments and/or field demonstrations.

COMMERCIAL POTENTIAL: Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) protection, lightning protection.

DNA95-20 TITLE: Fault Detection, Packaging and Testing

CATEGORY: Exploratory Development, Survivability and Hardening

OBJECTIVE: Improve the testing capability which stress operation or functional testing of densely packed systems and subsystems.

DESCRIPTION: The ability to test densely packaged systems and subsystems requires the development of new test vectors and a new screening process prior to testing at a radiation test facility. The objective of this topic is to develop and demonstrate innovative software and hardware that will: 1) ensure worst case stressing while testing in radiation or other hostile environments; 2) improve the fault detection with location of fault; 3) improve exercising software; and 4) improve low noise testing for high upset package parts in multichip modules or high density packaged circuits.

During Phase I the research will develop the feasibility of the proposed technology, methods, and concepts.

During Phase II, the research concepts developed in Phase I will be demonstrated or reduced to engineering practices.

COMMERCIAL POTENTIAL: Satellites, Information Highway.

BALLISTIC MISSILE DEFENSE ORGANIZATION (BMDO)
SMALL BUSINESS INNOVATION RESEARCH PROGRAM
Submitting Proposals

Send Phase I proposals (five copies of the full proposal, PLUS one copy of Appendices A and B only) by US mail to:

Ballistic Missile Defense Organization
Attn: TRI/SBIR
7100 Defense Pentagon, Rm 1D110
Washington, D.C. 20301-7100

For Administrative Help ONLY:
Call 800-937-3150

Proposals delivered by other means (commercial delivery service or handcarry) must be delivered to Room 1D110, The Pentagon, Washington, D.C. **WARNING: Only persons with access to the interior of the Pentagon building can reach Room 1D110. Delivery to a Pentagon entrance is not sufficient**. (NOTE: Not all courier services have access to the Pentagon.) BMDO will acknowledge receipt of proposals only if the proposal includes a self-addressed stamped envelope and a form (like Reference B) that needs only a signature by BMDO.

BMDO seeks the most innovative technology that might enable a defense against a missile in flight - lighter, faster, smarter, more reliable components. Proposers need not know details of possible BMDO systems.

BMDO seeks to invest seed-capital, to supplement private capital, in a product with a future market potential (preferably private sector) and a measurable BMDO benefit. BMDO SBIR will not further develop concepts **already mature enough to compete** for private capital or for government development funds. Phase I will show the concept feasibility and the merit of a Phase II for a prototype or at least a proof-of-principle. Phase I proposal competition will be judged mostly on degree of technology innovation. Phase II competition will also be judged strongly on future market potential. Phase II proposals may be submitted anytime after Phase I starts. Projects showing time sensitivity will be considered for Phase II start-up funding and Phase I proposals may include a post-Phase I optional task that will permit rapid start-up if Phase II is approved. Principal Investigators who are tenured faculty are not considered primarily employed by a small firm if they receive compensation from the university while performing the SBIR contract; any waiver must be requested explicitly with a justification showing a compelling national need; BMDO expects to grant no waivers.

BMDO intends Phase I to be only an examination of the merit of the concept with an average cost under $60,000. Although proposed cost will **not** affect selection for negotiation, contracting may be delayed if BMDO reduces the cost ceiling. Do not submit the same proposal (or variations) to more than one topic; each idea will be judged once in an open topic-blind competition among all proposals.

Because BMDO seeks the best nation-wide experts in innovative technology, proposers may suggest technical government reviewers by enclosing a cover letter with the name, organization, address and phone number (if known), and a rationale for each suggestion. BMDO promises only to consider the suggestion.

BALLISTIC MISSILE DEFENSE ORGANIZATION TOPICS

BMDO95-001	Directed Energy Concepts
BMDO95-002	Kinetic Energy Weapons
BMDO95-003	Sensors
BMDO94-004	Unit Cost Reduction
BMDO95-005	Non-Nuclear Power and Power Conditioning
BMDO95-006	Propulsion and Logistics
BMDO95-007	Thermal Management
BMDO95-008	Survivability
BMDO95-009	Lethality
BMDO95-010	Computer Architecture, Algorithms, and Language
BMDO95-011	Optical Computing and Optical Signal Processing
BMDO95-012	Structural Concepts
BMDO95-013	Structural Materials
BMDO95-014	Electronic Materials
BMDO95-015	Superconductive Materials
BMDO95-016	Surprises and Opportunities

BMDO TOPIC DESCRIPTIONS

BMDO95-001 TITLE: Directed Energy Concepts

DESCRIPTION: Innovative applied research in the generation and propagation of directed energy beams. Systems being considered include (but are not limited to) chemical lasers, excimer lasers, laboratory x-ray lasers, gamma-ray lasers, solid-state free electron lasers, and hybrid approaches. Included are such topics as weapon pointing, beam control, acquisition, tracking and pointing, mirrors, beam propagation, optics, and countermeasures.

BMDO95-002 TITLE: Kinetic Energy Weapons

DESCRIPTION: Kinetic energy (KE) weapons candidates presently include a variety of ground and space based interceptors including their propulsion. System elements include ground-based launchers, divert motors/nozzles, smart projectile components, and endo/exoatmospheric guidance and control mechanisms. Technology challenges for KE systems include: finding the booster hardbody within the plume, high performance axial and divert propulsion sub-systems (especially very low mass divert systems), miniature inertial navigation units, array image processing, C.G. Control algorithms, fast frame and UV Seekers, acquisition and track; target discrimination, seeker operational environments, lethality/miss distance; aero-optical effects, guidance and fuzing accuracy, shroud separation, window thermal-structural integrity, non-nuclear kill warhead performance, target acquisition in a nuclear environment, performance and survivability of electronics in nuclear environment; HVG lifetime, firing rate, projectile guidance and control and projectile launch survivability; and, common among all systems reliability; producibility, maintainability, and low cost/low mass; aeroshell ablation control; electromagnetic launches.

BMDO95-003 TITLE: Sensors

DESCRIPTION: Sensors and their associated systems will function as the "eyes and ears" of a space-based ballistic missile defense system, providing early warning of attack, target identification, target tracking, and kill determination. New and innovative approaches to these requirements using unconventional techniques are encouraged across a broad band of the electromagnetic spectrum, from radar to gamma-rays. Passive, active, and interactive techniques for discriminating targets from decoys and other penetration aids are sought. Sensor-related device technology is also needed. Examples of some of the specific areas are: cryogenic coolers (open and closed systems), cryogenic heat transfer, superconducting focal plane detector arrays (for both the IR and sub-mm spectral regions), signal and data processing algorithms (for both conventional focal plane and interferometric imaging systems), low-power optical and sub-mm wave beam steering, range-doppler lidar and radar, passive focal plane imaging (long wavelength infrared to ultra-violet; novel information processing to maximize resolution while minimizing detector element densities) interferometry (both passive and with active illumination), gamma-ray detection, neutron detection, intermediate power frequency agile lasers for diffractive beam steering and remote laser induced emission spectroscopy, lightweight compact efficient fixed frequency radiation sources for space-based BMDO application (uv-sub-mm wave), new optics and optical materials. Entirely new approaches are also sought.

BMDO94-004 TITLE: Unit Cost Reduction

DESCRIPTION: BMDO seeks drastically lower unit cost of components through manufacturing revolutions that will lead to high volume production from commercial sales. Thus BMDO will consider proposals that offer such a huge unit cost reduction that a heretofore purely anti-missile military technology would become a high volume commercial item. Whereas all other topics seek first and foremost a revolution in the miliary capability of the technology, this topic seeks only a revolution in the unit cost. BMDO seeks herein only projects that are too risky for ordinary capital investment by the private sector. The proposals must include and will be judged in part on an economic analysis of the expected market impact.

BMDO95-005 TITLE: Non-Nuclear Power and Power Conditioning

DESCRIPTION: Along the lines of Topic BMDO94-04, non-nuclear approaches are sought for high energy densities. The power duty cycles to be considered include: hundreds of MW power for burst applications, sustained tens of kW to MW power for electric propulsion, continuous tens of W to a few kW for house keeping, communications, etc. Specific topics include novel very long life battery concepts, chemically driven systems for burst power, advanced solar collectors and high efficiency multibandgap or thin film converters, inductive and capacitive stores, heat dissipation systems, signature control, plasma switches, and high temperature power electronics. Also, concepts and systems that improve maintainability and reliability of space power systems (e.g. low loss insulation and cable) are sought. Very light weight and affordable technologies are also sought as are concepts that can work in the van Allen belt, and after high acceleration launch. Power conditioning for terrestrial power (not terrestrial power generation).

BMDO95-006 TITLE: Propulsion and Logistics

DESCRIPTION: Missile defense places unprecedented demands on all types of space transportation and propulsion systems; launch to low earth orbit, orbit transfer, orbit maneuvering, and station keeping. In particular, advancements are needed to achieve major reductions in the costs of placing and maintaining payloads in the desired orbit. Approaches leading to techniques, methods, processes, and products in support of these propulsion and logistics objectives are sought. Propulsion approaches include liquid, solid, and electric. Advancements are needed in propulsion-related areas, e.g., extending storage time of cryogenic fluids (e.g. H_2 and Ze), reduction of contamination from effluent, and sensors and controls for autonomous operation. Areas of interest include the entire spectrum of space transportation and support: efficient launch systems for small technological payloads as well as full system payloads, assembly, and control systems; expendable and recoverable components; improved structures and materials; and increased propulsion efficiency. In anticipation of and solar power demonstration missions incorporating electric thrusters, BMDO seeks 10 to 30 kW electric thruster modules (e.g., electrodes, insulators, ignition systems, propellant control, command and control system, thermal management system, and power conditioning unit). With the advent of small surveillance satellites, low power (0.5 to 2 kW) electric propulsion is being considered for station keeping and orbit transfer; for such systems emphasis is being placed on achieving higher power densities for components of the integrated system (thruster, power conditioning unit, fuel control, gimbals, and fuel storage). Low mass interceptors require advances in divert (small thrusters) propulsion systems (either solid or liquid).

BMDO95-007 TITLE: Thermal Management

DESCRIPTION: The high power levels for space stations must dissipate heat at state-of-the-art capabilities for waste thermal energy acquisition, transport, and dissipation to space. Technology advancements are required in thermal management for both power generation systems, space platform payloads, and electronics. Some space platforms will require years of storage of large amounts of cryogens with minimum cryogen loss and high cryogen delivery rates under condition of zero-g, concept and devices for all types of space-based power cycles, and can satisfy these projected space platform requirements.

BMDO95-008 TITLE: Survivability

DESCRIPTION: Missile defense elements must survive determined attacks against the system, and the natural space environments (atomic oxygen, space radiation and micrometeorites/debris). Survivability technology is needed for threat sensing, creation of false aim points, and passive hardening. Contributions are sought in materials development and processing, component hardware, systems, design and analysis.

Threat sensors enable the defense elements to detect nuclear, laser and radio frequency weapon attacks, and to respond appropriately. Sensors which can characterize the threat according to direction of attack, and spectral characteristics are particularly noteworthy. Technologies to create false aim points are needed to operate against the threat support sensors, including radar, passive visible/IR sensors and seekers, and laser radar.

Passive hardening against the nuclear, laser, RF and pellet/debris environments is needed, in addition to hardening against the natural space environments. Elements have common mission critical subsystems. Sensor systems, communications antennas (RF and laser), attitude sensors, solar power, propulsion, structure and thermal control are all directly exposed to nuclear, laser, RF and pellet/debris in addition to the natural space environments. Materials and component designs which are intrinsically hard to these environments, and/or protective devices are needed. A key area is sensor subsystems, the components of which (baffle materials, mirrors, optics, structures, and focal plane arrays/read out electronics) must survive the laser, nuclear and IR environments. Nuclear and laser hard baffle materials, and devices for protection against unknown or agile lasers and

rejection of RF energy are of particular interest. Structures and coatings providing appropriate thermal characteristics, stability under mechanical impulses and hardness to laser and RF radiation are needed. Processors capable of operating in unique nuclear environments presented by the strategic application (i.e. multiple burst environments) while retaining full functionality.

BMDO95-009 TITLE: Lethality

DESCRIPTION: A major factor in determining the effectiveness of a ballistic missile defense is the lethality of the directed and kinetic energy devices against responsively hardened targets. New concepts to produce a much higher probability of kill-given-a-hit.

BMDO95-010 TITLE: Computer Architecture, Algorithms, and Language

DESCRIPTION: Missile defense systems for battle management demand order-of-magnitude advances. A system must acquire and track thousands of objects with hundreds of networked sensors and data processors, direct weaponry to intercept targets, and determine the degree of kill. Areas of interest are:

- New computer architectures which are robust, compact, and fault-tolerant, but allow for the extremely rapid processing of data. Architectures may be implemented by new designs or innovative applications of existing technologies, such as optical signal processing, systolic arrays, neural networks, etc.

- Very high-level language (VHLL) design for both the development and testing of extremely large software systems.

- Novel numerical algorithms for enhancing the speed of data processing for sensing, discrimination, and systems control. These may be specifically tailored to a particular system, for tasks (for instance, the execution of a phase retrieval algorithm for interferometric imaging). Includes neural networks.

- Language design to develop code optimized for highly parallel processed architectures.

- Testing techniques that will provide a high level of confidence in the successful operation of concurrent, real-time, distributed large-scale software systems. Examples include sensitivity analysis, data flow testing, mutation testing, static concurrency analysis, and dependency analysis.

- Computer network and communications security. R&D for trusted computer systems in accordance with DoD 5200.28.STD; integration of COMPUSEC with COMSEC (DoD 5200.5).

- Self-adaptive processing and simulation. Algorithms and architectures for advanced decision making.

- Neurocomputing and Man-Machine Interface - rule-based AI and neural networks combined for decision making flexibility and system robustness; development of decision trees and information display for highly automated, short response time, high volume scenarios.

- Software architectures for embedded computer networks that especially facilitate incremental system and software integration, hardware and software maintenance, and system evolution, without significant performance degradation.

- Hardware and software self-diagnostic capabilities for monitoring the operational readiness and performance of space and ground systems incorporating embedded computer networks.

BMDO95-011 TITLE: Optical Computing and Optical Signal Processing

DESCRIPTION: Dense computing capability is sought in all architectural variations, from all optic to hybrid computers. Specific examples of areas to be addressed include, but are not limited to, high speed multiplexing, monolithic optoelectronic transmitters, holographic methods, reconfigurable interconnects, optoelectronic circuits, and any other technology contributing to advances in intra-computer communications, optical logic gates, bistable memories, optical transistors, and power limiters. Non-linear optical materials advancements and new bistable optical device configurations.

BMDO95-012 TITLE: Structural Concepts

DESCRIPTION: Minimum weight structures are needed to withstand high-g loading, acoustic and thermal environment of ground based interceptors and to provide solid bases for space systems pointing and tracking. Such structures will benefit from: (1) innovative vibration control techniques, (2) innovative fabrication approaches to cut structure cost, and (3) innovative use of advanced materials and/or design approaches to minimize structure weight. For instance, techniques and experimental verification are needed for active and/or passive methods to measure and control vibrations caused by thermo-mechanical flutter, thruster firing or structure borne noise caused by on-board mechanisms. "Active" structural elements containing materials and electronics to provide predictable mechanical displacement in response to applied electrical signals are of interest. Maximization of displacement, mechanical strength, and reliability; parameter stability over extended temperature ranges; and minimization of driving voltage, power, and weight of these elements are desired. Producibility improvements for curved actuator elements, flextensional, and other integrated motion amplifiers are of interest. Fabrication approaches that provide minimum weight with reduced assembly, inspection, and scrap rates for conventional, advanced composite, and "active" structures are needed to reduce costs. Of course, clever design and material usage to reduce structure weight while maintaining or increasing capability are always desirable goals.

BMDO95-013 TITLE: Structural Materials

DESCRIPTION: Many of the anticipated structural advances sought in Topic 94-012 will depend on major improvements in material properties and cost effectiveness. Space structures supporting seekers and antenna must accommodate retargeting maneuvers without detrimental jitter from vibrations and thermo-mechanical flutter. Surface launched interceptors must withstand high g loads, aerothermal heating and structural vibration without compromising tracking accuracy. Lightweight materials are very beneficial for both ground and spaced based systems.

Specific goals require advanced techniques and processes that include imparting oxidation resistance and damage tolerance to composites and creating high elastic modulus composites for use over a broad range of temperatures. The following are sought: (1) innovative manufacturing methods for producing high modulus, fiber-reinforced glass, light metal (i.e., aluminum or magnesium), or resin matrix composites; (2) innovative procedures for the production of instrumentation, sensors and software for on-line process monitoring and evaluation of high modulus, fiber-reinforced composites during fabrication; (3) novel approaches to tailor fiber/matrix interfaces to maximize capability in advanced composites; (4) novel methods to cut fabrication cost of metallic and/or composite spacecraft and interceptor structures; (5) innovative tooling techniques for near-net shape production of advanced composites; (6) novel low-to-no outgassing joining/bonding techniques for advanced composites; (7) innovative surface modifications to promote wear resistance; (8) new methods for integrating instrumentation (e.g., embedded sensors) into advanced composite materials and structures; and (9) novel instrumentation for determination and telemetry of material properties and data from space. Advances are also sought in materials for optical system components, mechanical moving assemblies, and protective coatings.

BMDO95-014 TITLE: Electronic Materials

DESCRIPTION: The necessary advances in electronics for the many missile defense applications will require advances in electronics materials.. Primary emphasis lies in advancing the capability of integrated circuits, detectors, sensors, large scale integration, radiation hardness, and all electronic components. Novel quantum-well/superlattice structures which allow the realization of unique elective properties through "band gap engineering" are sought as are new organic and polymer materials with interesting electronic characteristics. In addition, exploitation of the unique electronic properties of single crystal diamond is of considerable interest. Among the many BMDO electronic needs are advances in high frequency transistor structures, solid state lasers, optical detectors, low dielectric constant packaging materials, tailored thermal conductivity, microstructural waveguides, multilayer capacitors, metallization methods for repair of conducting paths in polyceramic systems, and sol-gel processing for packaging materials.

BMDO95-015 TITLE: Superconductive Materials

DESCRIPTION: BMDO wants to demonstrate both high temperature superconductor (HTS) and low temperature superconductor (LTS) devices to enable or improve strategic defenses. Emphasis in HTS technology is in components integrated with state-of-the-art cryoelectronics for communications systems at K- and V- bands and radar systems in the X-band power and inductive energy storage. The demonstration of HTS materials to BLIP limited detection of radiation in the optical, IR, MWIR, and LWIR bands as well as for signal processing applications is also of interest. The emphasis in LTS technology is the development and demonstration of high sensitivity detectors, digital electronics and memory enabling on-focal plane array signal processing and

operating at temperature greater than 10K. Efforts should address packaging and interface issues and systems integration with cryocoolers and stored cryogens.

BMDO95-016 TITLE: Surprises and Opportunities

DESCRIPTION: Since BMDO is an exploration at technology's leading edge, it recognizes that surprises and opportunities may arise from creative minds. BMDO will consider proposals in other technologies where they present an unusual opportunity for BMDO. The proposer should take special care to describe the technology and why BMDO would benefit from exploring it. Proposers should note that proposals in this topic will receive preliminary screening that may reject them as too far afield without the full technical review received by proposals in the topics already listed. This open call is for new technology, not for recycling of old ideas.

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Special Operations Command's (USSOCOM) missions include developing and acquiring unique special operations forces (SOF) equipment, material, supplies and services. Desired SOF operational characteristics for systems, equipments and supplies include: lightweight and micro-sized; reduced signature and low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extreme temperature environments; water depth and atmosphere pressure proof; transportable by aircraft, ship and submarine, and deployable by airdrop; LPI/LPD jam resistant C3I, electronic warfare capable of disruption and deception; near real-time surveillance, intelligence and mission planning; highly lethal and destructive; low energy/power requirements; and compatible with conventional force systems. USSOCOM is therefore seeking small businesses with a strong research and development capability and understanding of the necessity for consideration of these SOF operational characteristics for systems. The topics on the following pages represent an introduction to a portion of the problems encountered by the SOF in fulfilling its mission.

USSOCOM invites the small business community to send its proposals directly to the following address:

United States Special Operations Command
Attn: SOKS/SBIR Program, Topic No. SOCOM95-00__
2408 Florida Keys Avenue
MacDill Air Force Base, Florida 33621-5316

The proposals will be distributed to the appropriate technical office(s) for evaluation. Inquiries of a general nature or questions concerning the administration of the SBIR program and proposal preparation should be addressed to:

United States Special Operations Command
Attn: Ms. Paulette Widmann
2408 Florida Keys Avenue
MacDill Air Force Base, Florida 33621-5316
Telephone: (813) 840-5443

The USSOCOM has identified four technical topics for this, the first of two SBIR solicitations to be released during FY 95 by DOD, to which small businesses may respond. The topics listed are the only topics for which proposals will be accepted. The topics were initiated by USSOCOM technical offices that manage the research and development in these areas. No direct communication with the topic author is possible. No additional technical information is available during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Please refer to Section 7.1 in this solicitation for further information on DTIC.

Firms are encouraged to submit a proposal for an option task which would be performed during the period between Phase I completion and Phase II contract award. The optional task provides the opportunity to reduce the gap between Phase I and II. The maximum amount of SBIR funding used for any USSOCOM Phase I award is $100,000. Proposals that include the option task shall not exceed $70,000 for Phase I and $30,000 for Phase I Option. Any option proposal must be submitted at the same time and place as the basic Phase I proposal and not be included in the basic Phase I proposal page limitation. The basic Phase I proposal shall be evaluated exclusive of the option task and must be proposed and priced separately. The option portion of the proposal shall not exceed 10 pages, not exceed $30,000, not exceed three months in duration, and be evaluated using the same evaluation criteria as Phase I proposals. The transition option work shall be included as an option in the Phase I contract and evaluated for USSOCOM unilateral exercise at any time after Phase I award through the conclusion of the basic Phase I contract. Exercise of any option shall be at the sole discretion of USSOCOM and shall not obligate USSOCOM to make a Phase II award.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in this solicitation. As funding is limited, USSOCOM reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals is deemed superior, or it may fund no proposals in a topic area.

US SPECIAL OPERATIONS COMMAND
FY 95.1 SBIR TOPIC INDEX

SUBJECT/WORD INDEX TO THE U.S. SOCOM TOPICS

U.S. SOCOM FY95.1 TOPICS

SOCOM 95-001 TITLE: Acoustic and Magnetic Signature Reduction for Outboard Engines

CATEGORY: Advanced Development; Materials

OBJECTIVES: To develop an advanced prototype of a standard, inventoried 55 hp outboard engine that has a greatly decreased magnetic and acoustic signature, and an increased hp to weight ratio.

DESCRIPTION: Influence mines are becoming more sensitive and the risk to operators in mined environments is increased because of the signatures of the outboard engines. This task will develop a cost-effective configuration of a standard outboard engine that has the lowest practical acoustic and magnetic signature.

Phase I: To determine the major magnetic signature components in outboard engines, and to rebuild undesirable parts using non-magnetic or low magnetic materials.

Phase II: To test and evaluate the configurations of low magnetic parts to determine the best arrangement for greatest reduction in acoustic signature and accompanying magnetic signature.

COMMERCIAL POTENTIAL: An advance in noise reduction for outboard engines; a much lighter engine with a much higher power to weight ratio.

SOCOM 95-002 TITLE: Maritime Platform Signature Reduction System

CATEGORY: Engineering Development; Marine Systems

OBJECTIVE: To develop a system to reduce the magnetic, infrared, radar, and acoustic signatures of maritime platforms.

DESCRIPTION: With the proliferation of shore radars, infrared imagers, and night vision devices, Naval Special Warfare forces require reduced signature platforms. A field modification kit is necessary to reduce the signatures of existing platforms.

Phase I: Assess the different signature reduction techniques and fabricate one prototype for testing. Conduct preliminary laboratory testing.

Phase II: Refine the design, fabricate and test under tactical field conditions. Provide estimated cost for production of field modification kits for the different platforms.

COMMERCIAL POTENTIAL: Use by law enforcement personnel in maritime drug interdiction activities.

SOCOM 95-003 TITLE: Low Signature Propulsion System

CATEGORY: Exploratory Development; Propulsion and Vehicular Systems

OBJECTIVES: To develop a low magnetic and acoustic signature propulsion system for Naval Special Warfare (NSW) underwater platforms.

DESCRIPTION: Design and fabricate a low magnetic and low acoustic signature propulsion system for use in a minefield environment. Emphasis should be on a small and lightweight alternative to the traditional electric motor, which creates an undesirable magnetic field. A need exists to create a powerplant suitable for use on Diver Propulsion Vehicles (DPVs) as well as larger underwater platforms. Primary emphasis should be on designing, prototyping, and demonstrating a DPV propulsion system for use by NSW forces.

Phase I: Analyze the specific design restrictions and expand on their propulsion concept showing specifically the power output and signature anticipated.

Phase II: Fabricate and demonstrate a prototype that demonstrates the Phase I concept.

COMMERCIAL POTENTIAL: Sport diving market if the technology is low cost and allows a magnetic compass to be mounted on a DPV without affecting its performance.

SOCOM 95-004 TITLE: Supercharged Diesel Non-Gasoline Burning Outboard Engine

CATEGORY: Engineering Development; Propulsion and Vehicular Systems

OBJECTIVE: To develop a diesel outboard engine that has an effective hp to weight ratio.

DESCRIPTION: Special warfare forces are required to depend upon many different platforms for deployment. These include submarines, small boats, and airplanes. There is a great need to remove volatile gasoline fuel from these platforms and replace it with diesel fuel.

Phase I: To determine the availability of supercharging technology and the accessibility of evaluating non-developmental diesel engines, to develop a working prototype.

Phase II: Based on the results of the prototype testing, select or design a diesel engine configuration acceptable to Special Forces and platform sponsors.

COMMERCIAL POTENTIAL: A diesel outboard engine with improved hp to weight ratio.

9.0 SUBMISSION FORMS AND CERTIFICATIONS

Section 9.0 contains:

Appendix A: **Proposal Cover Sheet**
An original red-printed Appendix A must be included with each proposal submitted.

Appendix B: **Project Summary Form**
An original red-printed Appendix B must be included with each proposal submitted. Don't include proprietary or classified information in the project summary form.

Appendix C: **Cost Proposal Outline**
A cost proposal following the format in Appendix C must be included with each proposal submitted.

Reference A: **Proposal Receipt Notification Form**

Reference B: **DTIC Information Request Form**

Reference C: **Directory of Small Business Specialists**

Reference D: **SF 298 Report Documentation Page**

Reference E: **DoD SBIR/STTR Mailing List Form**

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

____

CITY: ______________________ STATE: ________ ZIP: ________

PROPOSED COST: ________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Has this proposal been submitted to other US government agencies, or DoD components or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office and Topic Number in the spaces below.	☐	☐

____________________ ____________________

____________________ ____________________

▸ Number of employees including all affiliates (average for preceding 12 months): ____________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ____________________	NAME: ____________________
TITLE: ____________________	TITLE: ____________________
TELEPHONE: ____________________	TELEPHONE: ____________________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____

SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6902 (Commercial)

APPENDIX B

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

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Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

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Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6902 (Commercial)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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TOPIC NUMBER: ______________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

____

CITY: ______________________ STATE: ________ ZIP: ________

PROPOSED COST: ______________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Has this proposal been submitted to other US government agencies, or DoD components or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office and Topic Number in the spaces below.	☐	☐

______________________ ______________________

______________________ ______________________

▸ Number of employees including all affiliates (average for preceding 12 months): ______________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________	NAME: ______________
TITLE: ______________	TITLE: ______________
TELEPHONE: ______________	TELEPHONE: ______________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____

SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 363-7247 (800 DOD-SBIR)
(703) 274-6902 (Commercial)

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

INSTRUCTIONS FOR COMPLETING APPENDIX A

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APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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TOPIC NUMBER: ____________________

PROPOSALTITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

____

CITY: ______________________ STATE: ________ ZIP: ________

PROPOSED COST: ______________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	☐	☐
▸ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▸ Has this proposal been submitted to other US government agencies, or DoD components or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office and Topic Number in the spaces below.	☐	☐

______________________ ______________________

______________________ ______________________

▸ Number of employees including all affiliates (average for preceding 12 months): ______________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________	NAME: ______________
TITLE: ______________	TITLE: ______________
TELEPHONE: ______________	TELEPHONE: ______________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____

______________	________	______________	________
SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

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U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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PROPOSALTITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

______________________ ______________________

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MAIL ADDRESS: ____

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______________________ ______________________

______________________ ______________________

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U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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PROPOSALTITLE: ______________________

____

FIRM NAME: ______________________

PHASE I or II PROPOSAL: __________

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Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words that describe the Project.

______________________ ______________________

______________________ ______________________

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(800) 363-7247 (800 DOD-SBIR)
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APPENDIX C

U.S. DEPARTMENT OF DEFENSE
SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

TO: ____
Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 95.1
Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____
Fill in name of organization to which you will send your proposal.

______________________________ ____________
Signature by receiving organization Date

To: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program Solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires January 13, 1995, the DoD SBIR Program Solicitation No. 95.1 closing date.

REQUESTER ____
Name

ORGANIZATION NAME ____

ADDRESS ____
Street

____ PHONE ________________
City State Zip Code Area Code/Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1 ________	6 ________		11 ________	16 ________
2 ________	7 ________	*PLEASE TYPE OR PRINT IN THE ORDER TOPICS APPEAR IN THE SOLICITATION*	12 ________	17 ________
3 ________	8 ________		13 ________	18 ________
4 ________	9 ________		14 ________	19 ________
5 ________	10 ________		15 ________	20 ________

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation.

This is our first request during the current solicitation: yes____no____.

____
Signature of Requester

=================FOLD HERE=================

STAMP

Return Address

Defense Technical Information Center
Building 5, ATTN: SBIR
Cameron Station
Alexandria, VA 22304-6145

=================FOLD HERE=================

Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd., Suite 1107
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMAO San Francisco
ATTN: Robert Lane
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7041/7042

DCMAO San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 200
San Diego, CA 92111-2241
(619) 637-4922

DCMAO El Segundo
ATTN: Debbie Tatum
222 N. Sepulveda Boulevard, Suite 404
El Segundo, CA 90245-4320
(310) 335-3511/3495

DCMAO Seattle
ATTN: Alice Toms
3009 112th Ave., NE, Suite 200
Bellvue, WA 98004-8019
(206) 889-7317/7318

DCMAO Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92172-2700
(714) 836-2913 (ext. 659 or 661)

DCMAO Van Nuys
ATTN: Diane Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 904-6158

DCMAO St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5392 (ext. 231 or 229)

DCMAO Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6177

DCMAO Chicago
ATTN: James Kleckner
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021

DCMAO Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381

DCMAO Milwaukee
ATTN: Paul Roppuld
Henry S. Ruess Federal Plaza
310 West Wisconsin Avenue
Milwaukee, WI 53203-2216
(414) 297-4328

DCMAO Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloominton, MN 55425-1573
(612) 335-2003

DCMAO Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
(316) 269-7137

DCMD NORTHEAST
ATTN: John McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 348-1011 (Toll Free MA Only)
(800) 321-1861 (Toll Free Outside MA)
(617) 451-4317/4318
(617) 451-3174 (FAX)

DCMAO Boston
ATTN: Ann Howell
495 Summer Street
Boston, MA 02210-2184
(617) 451-4108/4109/4110

DCMAO Cleveland
ATTN: Herman Peaks
1240 East 9th Street
Cleveland, OH 44199-2064
(216) 522-5446

DCMAO Dayton
ATTN: Betty Adams
c/o Defense Electronics Supply Center
Building 1, 1507 Wilmington Pike
Dayton, OH 45444-5300
(513) 296-5150

DCMAO Detroit
ATTN: David Boyd
905 McNamara Federal Bldg, 477 Michigan Ave.
Detroit, MI 48226-2506
(313) 226-5180

DCMAO Garden City
ATTN: Eileen Kelly
605 Stewart Avenue
Garden City, NY 11530-4761
(516) 228-5724

DCMAO Grand Rapids
ATTN: Kay Hamilton
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620

DCMAO Hartford
ATTN: Frank Prater
130 Darlin Street
E. Hartford, CT 06108-3234
(203) 291-7706/7705

DCMAO Indianapolis
ATTN: Robert Staton
Building 1
Fort Benjamin Harrison, IN 46249-5701
(317) 542-2015

DCMAO New York
ATTN: John Castellane
201 Varick Street, Room 1061
New York, NY 10014-4811
(212) 337-0326

DCMAO Philadelphia
ATTN: Julia Graciano
2800 S. 20th Street, PO Box 7699
Philadelphia, PA 19101-7478
(215) 737-5818

DCMAO Pittsburg
ATTN: Rich Spanard
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926

DCMAO Reading
ATTN: Thomas Knudsen
45 South Front Street
Reading, PA 19602-1094
(215) 320-5012

DCMAO Springfield
ATTN: Sylvia Liggins
955 South Springfield Ave.
Springfield, NJ 07081-3170
(201) 564-8204

DCMAO Stratford
ATTN: Otis Wade
550 Main Street
Stratford, CT 06497-7574
(203) 385-4413

DCMAO Syracuse
ATTN: Ralph Vinciguerra
615 Erie Boulevard, West
Syracuse, NY 13204-2408
(315) 423-5664

DCMD SOUTH
ATTN: Howard Head, Jr.
805 Walker Street
Marietta, GA 30060-2789
(800) 551-7801 (Toll Free-GA)
(800) 331-6415 (Nationwide)
(404) 590-6196
(404) 590-2612 (FAX)

DCMAO Atlanta
ATTN: Sandra Scanlon
805 Walker Street
Marietta, GA 30060-2789
(404) 590-6197
(404) 590-2110 (FAX)

DCMAO Baltimore
ATTN: Gregory W. Prouty
200 Towsontown Blvd.
Towson, MD 21204-5299
(410) 339-4809
(410) 339-4990 (FAX)

DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, N., Suite 104
Birmingham, AL 35203-2376
(205) 226-4304
(205) 251-5325 (FAX)

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, Room 640
PO Box 50500
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